Abstract

WINEGARDEN, CLAUDIA REBOLA. Visualizing Communication Structures of Nonverbal Information for Online Learning Environments. (under the direction of Prof. Haig Khachatoorian, IDSA)

This doctoral level study aims to advance research in the visualization of Spontaneous Interactive Gestures produced by students in online learning environments, and how they can best be used as interfaces in compute-mediated communications. Visual channels, both gestural and graphical (Visual Co-Activations), will be evaluated in the performance of demonstrating participation and facilitating feedback (interaction) for online synchronous communication, more specifically multi-videoconferencing. The goal is to give a more naturalistic, integrative and interactive means of synchronous computer-mediated communication for use in future applications of distance education, based on the role of Visual Co-Activations of Spontaneous Interactive Gestures with the use of vision-based interfaces. A multidisciplinary approach within design, social and computer sciences is used in order to widen implications of the importance of design research for education and human development within computer technologies. This study employs multiple data collection procedures, a two-phase developmental design, in which qualitative and quantitative methods are employed sequentially to understand and determine the role of gestures in distance education application methods. Data suggests that joining both gestural and graphical nonverbal information is better visualized in group communication at a distance, but also demonstrates participation and facilitates interaction in online learning environments.

Title Page

Visualizing Communication Structures of Nonverbal Information for Online Learning Environments

By

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Dedication

I dedicate this research project,
principally to my parents.
I thank them endlessly
for always giving me
their advice and encouragement
with their own life examples.

Personal Biography

My name is Claudia Rebola Winegarden. I was born in Cordoba, Argentina in 1975. In 1993, I started my college education. In 1998, I completed my Bachelor of Industrial Design (BID) at the FAUD-UNC in Cordoba, with the highest GPA in my class, a Carlos Saul Menem Argentinean Presidential recognition for best student performance in the discipline, and different honors and publications. I won the first prize in an exhibit design competition. During those years, I was also a Teaching Assistant (TA) for the History of Industrial Design course for second-year students at the university for 3 years. I attended conferences on design, technology and education, and also ran a freelance design firm, Nexo Diseños, providing graphic and industrial design services. I have worked for companies, such as Emergencia Medica Integral S. A., Coviplan, Junior Achievement and San Miguel Golf Club, to mention a few, in which I developed design products addressing the needs of communications structures for a group— from an integrative modular system for communication technologies to the design of information that facilitates interaction and organization of systems that provide life-support. My bachelor's thesis involved using design as a synthetic tool, linking different disciplines towards educating and improving the human condition. In 1998, I applied for a Fulbright-Hays Grant. In 1999, I completed a full-time course in the intensive English program at Cornell University, and then arrived in Raleigh to complete a Master of Industrial Design at North Carolina State University, College of Design, sponsored by Fulbright-Hays Grant. For the two years, I worked on different projects for companies, such as DaimlerChrysler, Medicab, and Motorola. I also worked on freelance design for the Environmental Protection Agency, and temporarily as a TA taught Industrial Design courses at NCSU. Between my Master's study years, in 2000, I did an internship for Lowe's, Inc headquarters to help immerse design in the different departments of the company. In 2001, I received my Master's degree with a thesis that presented the impact of technologies in health and design fields entitled "GIMA—Global Intelligent Medical Agent". My final project showed how technology and the de-materialization of products could be humanized through design. This led the College to sponsor my doctoral studies in a new concentration of the PhD program in Information Design.

Along with my Master's degree, I received three important honors: Phi Kappa Phi, Tai Sigma Delta, and the Industrial Design Faculty Book Award for outstanding academic achievement in the graduate design curriculum with the highest GPA and design excellence. Since 2001, I have been sponsored as a Research Assistant (RA) for Prof. Haig Khachatoorian, IDSA. During 2002, I was selected PhD Student Representative, to contribute to the development of our PhD in Design program. In 2003, I became a PhD Candidate at NCSU, with the acceptance of my research proposal on "Visualizing Communication Structures of Nonverbal Information for Online Learning Environments". In 2004, I was hired as an RA by Dr. Michael Rappa, who leads the Open Courseware Laboratory at NCSU, to be the main interface designer of the group. My research interests match this important research group, which is trying to create online educational tools to facilitate communication between professors and students. For the past several years, I have also been involved in different research groups offering my design skills. I have worked at NCSU with the Natural Learning Initiative (NLI) with Prof. Robin Moore, developing information design concepts for research in childhood development; and the Mimesis Project with Dr. Michael Young, developing concepts in 3D virtual worlds. Lastly, my passion for design and the continuous exploratory approaches, both in the educational and industrial arenas have been grouped together into an emergent concept of Experience Design. My biography speaks to the fact that I am a passionate individual towards the study and practice of Design. My future plans are to continue teaching design, sharing my knowledge, and helping to grow a community interested in improving the health, both physical and spiritual, of our global society.

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I give thanks to the many, who believed
in the researcher, I have become today.

I thank my beloved husband Joe,
my family, dearest friends, and colleagues;
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Nomenclature

CMC – Computer-Mediated Communication

DE – Distance Education

HCI – Human Computer Interaction

OLE – Online Learning Environments

OVP – Observer Video Pro

NCSU – North Carolina State University

SIGs – Spontaneous Interactive Gestures

VBI – Visual-Based Interfaces

VCAs – Visual Co-Activations

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Prologue

Humanizing Technology Through Design

One of the first questions, I am always asked, is
"What do you do?" In the many ways I can answer the question, it can be generalized that I create experiences for people through the design of both physical and graphical products; products that impact on environments, materially and spiritually, physically and psychologically, socially and culturally.

I am a designer of human-centered products, treating time and space with the constant aim of creating new potentials in day-to-day living. I am interested in augmenting human beings, both cognitively and affectively. I try to provide daily harmonious interactions for consumers through encompassing the themes of quality and natural service as cornerstones of personal experience and advanced awareness, where computers have become an integral part of the design process. Touch, sight, hearing, smell, and taste…all are challenges affecting the design process in computation that can be solved with a sixth sense, called creativity. This is a designer's gift to humanity.

My research study speaks of my concerns with the design discipline within the technological realm. My interests rely on enhancing the human experience in interacting with and through computers. With the impact of recent technologies, computer products are changing the way humans experience the world in their daily lives. Products are crossing the tangible and intangible limits, converging into one holistic experience, affecting our sense of time and place. Yet, my eventual goal is to advance the integrative solutions for a seamless type of human-to-human interaction with the use of technologies.

This research is an example of my design motivations. It shows a vision of the use of innovative technologies to promote contemporary educational practices and to provide better online instructional environments, supporting more fluid and effective forms of discourse in-group interaction for teaching and learning. The need is to advance research in which gestures are natural languages interfaces that people use to communicate, therefore input devices, in which computer systems would have the ability, vision, to understand and respond through the use of visual interfaces—visual co-activation to the non-verbal information and message.

After all, matching the complexity of human beings with the advancements of technology causes us all to think about design as a synthetic activity, where design serves as a style of life, as a framework to bring order to the world we live in.

Chapter 1

Introduction

Purpose of the Study

This research study visualizes Spontaneous Interactive Gestures (SIGs), produced by students in online learning environments with the use of Visual Co-Activations (VCAs). The goal is to concentrate on nonverbal information—visual designs as cognitive/affective interfaces, with the intention of proposing meaning-making tools to facilitate communication and comprehension in a group. Joining visual channels, both gestural (SIGs) and graphical (VCAs) could aid performance by demonstrating participation and facilitating feedback, thus enhancing interaction for online synchronous communication, more specifically multi-videoconferencing. Therefore, it is the intention of the study to create the augmentation of the SIGs meaning through VCAs by stressing the content of the gesture as a functional mediator and facilitator of communication. Raising one's hand across the group to signal calling for attention could be visually augmented with the use of graphical interfaces, such as a number to express the order of the intention.

This study also advances the premise that the use of VCAs of SIGs in Computer-Mediated Communication (CMC) can facilitate interactive group participation and feedback in multi-videoconferencing environments. Research literature indicates that the use of gestures for computer applications is not only an effective means of communication (Kurtenbach & Hulteen, 1990), but also plays a crucial role in teaching and learning, in which it can facilitate the communication and learning process between students and teachers (Goldin-Meadow, 1999, 2003a, 2003b; Valenzeno, Alibali, & Klatzky, 2003). Gestures possess an inherent, visually symbolic representation of meaning not often encountered in speech (Goldin-Meadow, 1999; Iverson & Goldin-Meadow, 1998; Kita, 2000, 2003; McNeill, 1992, 2000). They might augment the information space—concrete experience—and establish better group communication by increasing the physical visual reception of information; stressing Lakoff's belief that cognition is embodied, Zull's framework promotes that learning is physical (Lakoff & Johnson, 1999; Zull,

2002). Gestures keep a set of conceptual spatio-dynamic properties activated (Kita, 2000), therefore functioning as a tool for communication for listeners and a tool for thinking for speakers (Goldin-Meadow, 1999). Spontaneous gestures are major unconscious vehicles with functions of regulating the flow of conversation while signaling the search for feedback during an interaction (Cassell, 1998, 2000). Consequently, the literature suggests that gestures in education, is a better means of communication and learning, when incorporated. Secondly, the process of utilizing gestures empowers performers to speak more, therefore, to better participate and interact in the group. Thirdly, linking the field of gestures in education to the realm of computer science is a goal to advance interfaces that promote more integrative, naturalistic and interactive learning experiences with the use of advanced technology.

Current literature in distance education indicates the need for more efficient interactive mechanisms that can incorporate the benefits of face-to-face communication (Comeaux, 2000). This research focuses on identifying and testing the visual co-activation of SIGs that can augment the meaning of the message sent to an online group. The researcher employs multiple data-collection procedures—two-phase and developmental design, with the use of qualitative and quantitative methods (Creswell, 1994; Greene, Caracelli, & Graham, 1989). The goal is to determine and explain the role of gestures in distance education application methods and demonstrate how information design research and practice can improve group interaction communication.

The literature on gestures in computer applications, as input devices, ignores the issue of selecting the content of gestures for specific contexts (Bretzner, Laptev, Lindeberg, Lenman, & Sundblad, 2001; Cipolla & Pentland, 1998; Guangqi, 2004; Porta, 2002; Sebe, Lew, & Huang, 2004; Wachsmuth & Fröhlich, 1998; Yang & Ahuja, 2001). However, there is a need to understand the qualitative aspects of human discourse in computer environments (Quek et al., 2002).

In Phase One, a qualitative study concentrates on identifying the number and content of participatory SIGs in which college students are able to produce in synchronous communication interactions, both in a traditional classroom and

remote learning environments. The study advances and captures the experimental variables in fieldwork – grounded theory. As such, ethnographic studies are employed to understand the qualitative functions, content (emotional and cognitive meanings) and the number (towards a taxonomy) of SIGs that support and affect the nature and effectiveness of participation. It also addresses how SIGs can facilitate, engage and manage interaction in the classroom environment.

The Observer Video Pro 5.5 (OVP) software tool is used to identify gesture patterns in classroom interactions and to determine which gestures promote participatory outcomes (Noldus, 2003). With OVP, gesture interactions were coded from direct observation videos across learning environments in order to develop a participatory SIG vocabulary. In addition, open-ended interviews were conducted with students to support and validate the analysis of observational data. In Phase Two, quantitative research concentrates on experimental studies testing the VCAs of identified SIGs variables from Phase One. This is undertaken for the purpose of testing synchronously reactive visual interfaces from a particular student, and across the group in distance education. Channels of visual (nonverbal) information, both gestural (SIGs) and graphical (VCAs), are measured under three conditions: SIGs Group, which relies on measuring only gestural performance channel; VCA of SIGs Group, which relies on measuring both gestural and graphical performance channels; and VCA Group. The aim is to create and test how different visual attributes from the performance of SIGs provide rapid immediate assessment of the intentional task. The two-phase design was conducted at a public institution at the level of graduate education at North Carolina State University. The institution is a leader in information technology with a large population of students having high computing literacy involved in a diverse number of online applications as Distance Education. The outcomes of this research study will generate new knowledge and provide foundations for the next generation design practices that validate the potential use of gestures - non-verbal information - as input devices and interfaces toward more effective uses and adoption of computer technologies in distance education, especially in multi-videoconferencing online learning environments.

Chapter 2

Definition of Terms

The term ***"Visualize"*** in this research study refers to highlighting or making clear a hierarchy among non-verbal elements of a visual field and/or identifying changes in their states of being.

"Nonverbal Information" refers specifically to the visual channels of information both gestural (Spontaneous Interactive Gestures) and graphical (Visual Co-Activations).

Therefore, ***"Visual Co-Activations"*** are responsive graphic interfaces, based on color and shape (i.e. red border/square), on computer screens that are activated from the user gestures. The VCAs would be produced by vision-based interfaces in which computer systems visually convert the gestural dialogue into a graphic interface by recognition.

Intrinsic to the SIGs concept is its natural performance. The term ***"natural"*** refers to hand gestures that are produced in human-to-human communication in their naturally occurring context; and are not forced, changed or conditioned artificially in their production.

"Spontaneous" is defined as a type of gesture that in the manner of their production (McNeill, 1992) are believed to be less conscious, recallable, conventionalized or voluntarily controlled (Kendon, 1997).

"Gestures" are defined as nonverbal phrases of actions (Fast, 1970), describing explicit, symbolic or representational cues revealing cognitive properties (Goldin-Meadow, 1999, 2003a). Gestures involve a wide range of nonverbal human communication, which include body language, facial expressions, hand gestures, and sign language. This study focuses only on hand gestures, which are the most expressive part of the human body (Givens, 2005) showing emotions, depicting ideas, pointing out objects, drawing invisible objects, etc. Within this paper, the term *gestures* is used interchangeably with SIGs; both are referring to spontaneous hand gestures.

"Interactive" is interpreted as the student's communication of participatory intent through nonverbal actions (gestures), such as raising the hand across the group in the classroom environment.

"Learning Environments" include the settings of classroom environments in which people meet (college students and professors) for educational purposes. Within this paper, two differentiated college learning environments are defined. First, ***"Traditional Classrooms"*** are the physical places, where the learning group meets. The class meets in a specific geographic location and interaction occurs in real-time. Second, "***Online Classrooms"*** are the virtual places, where the learning group meets. Unlike traditional classrooms, students or professors are remotely located and interaction occurs in real-time. Online classrooms are part of Distance Education.

"Distance Education" is defined as "Institution-based, formal education, where the learning group is separated geographically, and where interactive telecommunication systems are used to connect learners, resources, and instructors" (Simonson, 2000 p.1). Within this study, *Distance Learning* will be studied via remotely located and synchronous interaction/communication between the professor and students. The terms *Distance Learning, Distance Education* and *Online Learning Environment* are often used interchangeably, and the researcher follows this convention throughout the paper.

An "***Input Device"*** is defined as: "part of the means used to engage in dialogue with a machine…unlike human-human communication, the dialogue is between fundamentally dissimilar agents, in terms of both perception and processing" (Card, Mackinlay, & Robertson, 1991 p.101). Within this paper, SIGs demonstrate that they can be used as input to support communication interaction in online classrooms.

"Video Conferencing" is an interactive telecommunication system, which uses cameras that allow *two-way* audio and video output for remotely located students and teachers in a real-time, synchronous communication structure, and which *replaces* the face-to-face interface. Therefore, ***"Multi-video Conferencing"*** is an interactive telecommunication system, allowing a large

number of remotely located people to transfer audio and video from one to another, simultaneously and synchronously.

"Vision-Based Interfaces" (VBI) are a type of computer technology developed to give vision to computers, and thus the intelligence to recognize movement. VBI is a class of perceptive user interfaces, providing the computer with artificial vision capabilities, as a new input modality, in addition to or in replacement of standard interaction paradigms with computers (Porta, 2002). It makes use of computer cameras, which can recognize gestures in order to execute tasks, based on the movement or visual information processed. Inherent in the VBI paradigm is the concept of "***Natural Language Interfaces"*** (NLI) in giving computers the equivalence of the human senses and the ability to interact with people in the same fashion that people interact with one another.

Linking the application of computer multi-video conferencing with VBI increases the potential for students and professors to interact and collaborate as a group. The concept of communicating with others through the use of computer technologies is referred to as "***Computer-Mediated Communication"*** (CMC). This process is also known as "***Computer Supportive Collaborative Work***" (CSCW) or "***Groupware"***.

Chapter 3

Review of the Relevant Literature

This section presents literature related to the topic of study. The purpose of the literature review is to inform the reader with updated material that justifies the need for conducting this research project.

The researcher did not find literature directly relevant to the proposed topic. Rather, a collection of literature from different fields that supports the topic under study is presented. That is, the literature is discussed under four main categories: Design, Social Science, Computer Science and Education. Within each area, the reasons, motivation and concerns driving this research project are explained.

Research Inquiry from Design

What is Information Design?

Penman & Sless (1992) state that Information Design is about managing the relationship between people and information, so that the information is accessible and usable by people. They propose the idea that design functions as the mediator of the communication process between user and data, so as to make data intelligible. Zwaga, et al (1999) state that information design consists of the development of an effective organization of data, to change that data into meaningful information. Then the task of the information designer is the development of an instrument to translate the information. The emphasis in both definitions is that the particular perspective of information design is towards designing tools to transfer meaning and facilitate the communication interaction of the nature of data and its user/receiver.

Cognition as Context for Information Design

In research, it is extremely important to understand the context in which the study lies. The same phenomena can be studied in different contexts and

have a completely different outcome in each. Knowing what the discipline is all about, the next step is to understand what its context of investigation is. The context of the information design discipline is the relationship of the communication of the user with information. The relevance is in the interaction process on both ends. As such, the relevance relies mainly in understanding the user and thus the cognitive system of the user towards the nature of the data. There is an extensive amount of relevant literature on the topic of cognitive science and cognitive psychology. The intention of this section is to provide a short overview of how the mind operates in order to understand the parameters in which the communication interaction unfolds.

At its most basic level, cognitive science can be defined as the study of the interplay between perception, cognition, action and the relation between life and mind, where the mind is an interdisciplinarily embodied and environmentally embedded phenomenon (Clark, 2001). Clark states that there are three main characteristics that define a human: we have emotions that shape our daily experience; we have a system for making thoughts and reasons memorable; and the existence of a metaflow of thoughts through reflections on reason. That is, our thoughts learn from one another and subsequent thoughts. The key matter is to understand the ways of thinking processes that support a degree of prediction. Thus, realities are constructed on the basis of previous experiences and shaped by emotion and memory that determine future behavior. Moreover, motivational-emotional systems of the brain (amygdale) is responsible for modulating cognitive functions (Zull, 2002).

Memory in cognition plays an important role in understanding the thinking process in that it manages the mental events and knowledge we use, when we recognize an object or solve a problem (Ashcraft, 2002). Consider attention and the role of short- and long-term memory to understand the functioning of cognition. Ashcraft defines attention as "the mental process of concentrating effort on stimulus or a mental event" (p.121). Ashcraft explains that short-term memory is a component of the mind in charge of holding the immediate attended information (up to 20sec). Short-term memory communicates with long-term memory to virtually store permanent information. How we recognize in short-term memory and remember in long-

term memory depends heavily on the sensory inputs and stimulus, which can vary from auditory, tactile, olfactory, and/or visual.

In the process of recalling information, visual perception plays a crucial role, because it serves as the intersection of the environment and the human cognitive system from a presented stimulus. Visual attention seems to have a higher impact on attention than verbal, since its capacity is larger than the verbal. However, a general characteristic of visual attention research involves the procedure of overload. Several experiments over the years have proven that visual attention is able to deal with issues of complexity, concerned with multiple presentations of information. This is possible through the process of filtering out unwanted information. Which information is considered wanted depends on a variety of physical characteristics that are able to reduce conscious awareness and heavily demanding attentional resources (Shiffrin, 1977).

Visibility for Design

Consider that vision is a collector of information searching and selection under the guidance of cognitive process. Vision provides one of the greatest benefits in dealing with the environmental information, but attention is what makes the message readable, where form, color, motion and special position affect the outcome. How we search, attend to specific pieces of information and understand and act on information is the main task of the information designer. Visualization can be considered a powerful tool for augmenting the human cognition. Ware (2004) states that, until recently, this term has been used to explain how an image is constructed in the mind. However, Ware's most recent definition states that visualization is a graphical representation of data or concept, where from being an internal construct of the mind, visualization becomes an external artifact supporting decision-making with the following advantages:

- Ability to comprehend huge amounts of data
- Perception of emergent properties not anticipated
- Data is immediately apparent

- Facilitates understanding
- Facilitates hypothesis formation

Visualization derives from the graphic representation of variables associated with the concept that one wants to follow (Dürsteler, 2004). The key idea is that human beings can make use of tools (visualization) to extend their physical capacities, with the ability to convert the bulk of information into meaningful representations of the mind. As such, the visual properties compound a major part in cognition and perception and how abstraction/representation is transformed in the mind. The main problem is that we are able to perceive, as much as we are able to identify. The question relies on: what is the influence in overlaying an abstract visual system, on top of other visual systems, such as gestural?

Visual metaphors aid the process of conceptualizing and meaningfully interpreting (Indurkhya, 1992). We rely of metaphors (simile and analogies) and schemas to make sense of our experience in the world. There is a presence of transference of meaning based on similarity between the target (the abstract object with implicit description) and the source (the concrete object with explicit description). The essence of metaphors and schemas is the duplication of meaning to structure relationships by virtue of the human perception. The goal of having a dual channel of information is to facilitate the construction of meaning-making and problem-solving of the source content itself. Dual coding or two visual channels are efficient, when they hold the same meaning, so that one shares information to the other. Designing visuals metaphors may ensure that the target and message are detected by a viewer without environmental effort. However, the problem here is not to merely design visuals, but to shift focus to the cognitive processes that shape those visuals. In other words, the need is to concentrate on information designs as cognitive artifacts, with the intention of proposing meaning-making tools, which refer to the comprehension of such information. Moreover, the goal is to create the augmentation of meaning by stressing the content of the information source as a functional mediator of communication.

Understanding is Physical

The recent philosophical contributions in cognitive science stress the ideas that the mind is inherently embodied, thought is mostly unconscious, and abstract concepts are largely metaphorical cognition embodied in the physical world (Lakoff & Johnson, 1999). In other words, the mind is "shaped crucially by the peculiarities of our human bodies, by the remarkable details of the neural structure of our brains, and by the specifics of our everyday functioning in the world." (p.4) Moreover, since the mind is shaped by physical nature and thought is mostly unconscious, the mind does not operate simply by self-reflection, but as a construction from interacting with our environment. As such, our conceptual thinking is grounded in the physical and external world. This thought is also shared by Zull (2002), when he states that understanding as the result of meaningful learning is physical. But what do they really mean by physical and embodied meaning? Zull stresses the concept that "meaning itself is physical…this is why we need metaphors…without references to physical objects and events, there is no meaning" (p.6). The brain senses the environment (physical input) and integrates the input in order to generate actions, so that change occurs (physical output). All products of the mind come from the brain and the interaction between the body and the world. That is to say that our relationship and interaction with the outside world is inherently physical and we need connections or conceptualizations, such as metaphors and mental schemas that operate in our perception of the world in order to understand it.

Focusing on Content

The information design discipline has been heavily focused on design presentations of information. The content of information has been used to deliver a fixed product to the end user. However, the content of design should not be a fixed product, but rather a vehicle for user-centered dynamic construction of meaning. This concept has been born from the current implications of computer technologies in information design. Carliner (2000) claims there is a new way to deal with information within online interaction-computer technologies: moving from a focus on the tools to produce content, to a focus on the content itself. This latter idea has also been

developed by Kazmierczak (2003), when she states that "building a meaning-based model of design removes the fixation on produced things, and focuses attention on the human cognitive processes of communication … designers' design interfaces as bridges enabling the receiver's transition from one or any of a number of mental states into other ones." (pp.5) Therefore, the need relies on stressing the idea of designing more thinking tools that allow one to construct meaning, based on the content of information. The problem here is not to merely design visual interfaces, but to shift focus to the cognitive processes that shape those designs. In other words, the need is to concentrate on information designs as cognitive artifacts, with the intention of proposing meaning-making tools.

Research Inquiry from the Social Sciences

What are Gestures?

> *"The hand is not a hand but a character, the movement of the hand is not a hand in motion but the character in motion, the space is not the physical space of the narrator but the narrative space, the wiggling fingers are not fingers but running feet"*
> *(Mc Neill, 1992 p.20)*

Gestures are the natural capability of human beings to move the body parts with the purpose of expressing and communicating intentions that regulate behavior. There are many definitions of gestures, but Goldin-Meadow (2003a; Ott, 1902) can be dated as one of the first ones: "Gesture is a term which, in its widest sense, covers all of the bodily movements, by which man expresses thought and emotion" (p.vii). Ott wrote a book designed to help those who want to become good speakers, especially in theatrical oratory. Its purpose was to teach how to gesture, grown out from the studies founded on the expression of the emotions, mainly concentrated on bodily expression. Fast (1970) also defines gestures in terms of emotions: "Body language can include any non-reflexive or reflexive movement of a part, or all the body, used by a person to communicate an emotional message to the outside world" (p.11). As Cassell (1998; 2000) defines it, gestures are natural expressive and functional social tools of behavior. Gestures involve a wide range of

nonverbal human communication, which includes body language, facial expressions, hand gestures, and sign language. "Gestures are fascinating things, at once wholly expressive and curiously mysterious. The flick of the wrist, the wave of a finger, or simply the movement of an eyelid can say more than speech, and sometimes a subtle gesture can express a feeling more gracefully than words" (p.1) (Armstrong & Wagner, 2003). Also, Givens (2005) defines gestures as a "nonverbal sign: a body movement, posture, or material artifact, which encodes or influences a concept, motivation, or mood (thus, a gesture is neither matter nor energy, but information)." Furthermore, he understands information as a knowledge product derived from communication, based on cues and behavior that convey meaning about not only social status, such as dominance and submission or feelings, such as interest or boredom, but more importantly about conceptual thoughts, such as certainty and uncertainty. We can study gestures at the body level, what we can communicate with our posture by crossing the legs (Fast, 1970). The distance from someone that we set the body, when talking to people, can tell us how intimate a person is and even their cultural background (Hall, 1966). We can also study the facial expressions as gestures and what can be communicated about our personality, mood, emotions and thoughts from the 97 combinations of movements of our faces (Ekman, 1999). Among others, we can study hand gestures, all having an extraordinary ability to communicate behavior. However, as Givens (2005) notes, hand gestures are the most expressive part of the human body showing emotions, depicting ideas, pointing out objects, drawing invisibles objects, etc. This idea is also extended by Ackerman (1990): "Hands are messengers of emotion" (p.118). Around 700,000 different positions can be encountered of hand gestures, combined with arm and finger movements (Davis, 1975). We can hide our face in our open palms, pray with our palms pressing together, press our palm on our cheek when we are startled, move our hands as we pace, etc. Hands do not randomly move in space, but provide a meaningful tool to communicate with in which people are mostly unaware to read and understand the content of the message.

Gestures are Context Sensitive

> *"Singly, nonverbal behaviors may not have implicit meaning; they should be considered in context" (Miller, 1986 p.5)*

Understanding how hand gestures are used and how hand gestures are structured depends on how they are embedded in the context. The role of context is an essential component of how hand gestures unfold. The same gesture can hold a different meaning across situations (Goldin-Meadow, 2003a; Iverson & Goldin-Meadow, 1998; McNeill, 1992, 2000). In fact, several hand gestures are dependent on the cultural and social context in which they are developed (Archer, 1991). Consider the example of raising the hand with the index finger pointing up. This hand gesture can represent different meanings depending on where it is executed, such as counting, calling for attention, indicating up, pointing to the sky, calling for a taxi, etc. Not only does hand gesture meaning always occur in the situational context, but also its patterns of form and function and the underlying levels of meaning are sensitive to features of that context.

Gestures in Learning Environments

> *"As every gesture is but the muscular response to some activity of the mind…every motion should be subordinated to its purpose" (Ott, 1902 p.ix)*

Different researchers have documented the relationship of hand gestures in context. However, little literature exists on the study of hand gestures in learning environments. The most extensive literature has been written by Neil (1991). Neill has researched nonverbal communication in education for many years. He states two major reasons for the importance of nonverbal signals in the classroom, which are also shared by Miller (1986). First, it should be acknowledged that having the ability to understand the nonverbal channels increases the communication space in the classroom environment, especially when having a large group. The idea is to become better receivers of student messages. As such, the nonverbal channels would aid in understanding complexity in the classroom environment. Second, it helps a teacher to

understand the classroom dynamics and to adjust the learning material. The author indicates that teachers need to be able to make a rapid assessment of what is going on in the class for the class to have effective communication and, therefore, for the class to learn effectively. The teacher needs immediate feedback, which is based on gestures, so as to gain the ability to send students positive signals that reinforce learning. Gestures should have immediate, clear, precise meaning (rather than ambiguous). Through nonverbal behavior that gives immediate feedback as to whether students are learning effectively, teachers are able to address any gaps in understanding as they arise. In other words, this means that gestures can keep active participation in the subject matter and ensure learning.

Miller (1986) says that effective teaching depends on successful communication, where the teacher should have the ability to understand the nonverbal dimension: "A good teacher is a good listener, not only to words being spoken, but also to silent messages that signal agreement/ disagreement, attention/inattention, boredom/interest, and the desire of the student to be heard" (pp. 22-23). Even though the focus on gestures relies at a general level (as opposed to hand gestures only), he proposes studying the dimension of nonverbal behavior that includes understanding the territory in the classroom (open space, closed space), feedback (positive, negative), ability to listen (attentive, inattentive), etc. He concludes that by understanding the dimensions, nonverbal communication seems to be more effective in (explaining the shape of something), expressing feelings and evokes immediate action. Messages are more genuine, since they are more congruent than words. They send quick and subtle signals of thoughts linked to an emotional value. As such, gestures not only reveal emotion, but also thinking processes, especially in the context of learning environments. However, there is a need to understand the impact of hand gestures only in the learning environment. Consider the research conducted by Goldin-Meadow (2003). She states that hand gestures play an important role in teaching and learning, in which they serve as both a communication tool for listeners and a tool for thinking by speakers (Goldin-Meadow, 1999). She further states that hand gestures have a pedagogical value, promoting learning since they provide a second representation besides speech –

multiple representations can enhance learning. She conducted research with children, in which the findings indicate that a child would produce a gesture that conveyed the same information they just articulated in speech; a child would give one explanation in speech and a completely different explanation in gesture (gesture-speech mismatch concept). Those gesture-speech mismatches have cognitive significance. Therefore, gestures not only reveal a child's unspoken thought, but give a notice of their readiness to learn new things. Other researchers have also found that gestures facilitate learning (Valenzeno, Alibali, Klatzky 2003). They conducted studies with children to investigate, whether a teacher's gestures influence student comprehension of instructional discourse, and thereby influence student learning. They conducted a comparative study with the presence of and without the presence of gestures to understand their effect. Even though their study demonstrated the pedagogical value of gestures, it focused on the role of gestures in conveying substantive information relevant to the lesson content, rather than regulatory or interactive information. Also, they discovered that the nonverbal channel, as a secondary form of speech, better supports comprehension. Understandably, gestures aid communication mainly in ambiguous or verbally mismatched messages, since they are believed trustworthier than verbal information. However, literature on this topic has only focused on lower level educational settings in the study of children's gestures, rather than those of college, and whether gestures play an important interactive source of student's information. Moreover, the argument is that gestures need to be understood by and readable by the receiver to be efficient in learning environments.

Focusing on Hand Gestures

Hand gestures can be used for communication as nonverbal actions (Fast 1970), such as using the hands as regulators (Ekman, 1999; Kendon, 1997). However, gestures can serve not only as regulators of information, but also to phrase different types of actions. Not only is the concept of defining gestures broad, but also the defining of the broad and different types of hand gestures classification. As many researchers describe, gestures vary from the continuum of physiological gestures, such as itching, to more advanced mental production.

Literature indicates that researchers are working on a taxonomy of different hand gestures, in which to some extent, the different names attributed to gestures hold the same meaning (qtd. Krauss Chen and Gottesman, 2000) and Ekman and Friesen, 1969 in (Goldin-Meadow, 2003a; Kendon, 1997; McNeill, 1992). However, Efron and Kendon (qtd. in (McNeill, 1992) were among the first researchers to propose a gesture classification and continuum that has been built on for gesture generation and interpretation (Cassell, 1998). The latest hand gesture classification has been developed by Mc Neill (1998), in which he describes the difference between the conscious and spontaneous production of hand gestures. Focusing mainly on the spontaneous hand gestures, McNeill proposes a classification of gesticulation or spontaneous gestures, such as hand gestures: **iconic or illustrators**, which are descriptive gestures, since we move our hands to build the concrete representation; **metaphoric**, which are also descriptive gestures, but we move our hands to build abstract concepts; **beats**, also known as baton gestures, since we move our hands in pulsation with speech; **cohesive** gestures to link transition from the verbal channel; and **deictic** gestures, more commonly known as pointing gestures.

Also, there are other classifications of the more conscious production of gestures: **emblems**, which are mainly culturally bound (such as the OK sign); and **sign language**, such as the American Sign Language (ASL), where specific hand sequence of movement of your hand can phrase meaning. The various literature proposes a classification of gestures, but there is a gap in knowledge of the spontaneous gesture production of what type of hand gestures are used in the classroom environment and how particular hand gestures can be used as markers to organize conversational interaction, and thus exchange of information. For example, Goldin-Meadow (2003a) focuses on studying hand gestures with the limitations of excluding gesticulations, labeled as **adaptors** (how we move our hands when we speak, such as smoothing your hair, pushing your glasses up on your nose, etc). She argues that adaptors are performed with little awareness and no intent to communicate. However, adaptor hand gestures may reveal affective and cognitive information in learning environments.

Gestures Production

> *"Seems to be the fact that we can inherit in our make up certain basic physical reactions…we are born with the elements of nonverbal communication…we can understand that our non-verbal language is partly instinctive, partly taught and partly imitative" (Fast, 1970 pp.22-23)*

Nonverbal communication appears to be innate, but developed with the ability to copy. Nonverbal ability seems to be related to general cognitive ability since Neill (1991) explains that it is a general skill in decoding nonverbal cues seems to be accompanied by specific skills in decoding visual cues. Further, he states that children start with a range of signals, which appear to be innate. Children might gesture more because of developmental reasons, but as age increases the better the performance.

Gestures have a greater explicitness than the use of the verbal channel only. Nonverbal signals are less easily controlled than words and thus, potentially offer reliable information to both teachers and children on each other's intentions; but they are more ambiguous than words (Miller, 1986; Neill, 1991). Moreover, clinical studies have revealed that body language may contradict verbal communication (Fast, 1970). Even though nonverbal signs are a reliable source of information, their ambiguity creates an extensive problem in differentiating one intention from another. Neil states that the same signal production has different meanings according to which other signals are combined. Also, the production in many of the cases is an unconscious production, in which people cannot describe precisely or name them; lack of conscious awareness and control signals with a range of meanings will depend on its context. As such, the reception of those nonverbal signals is sophisticated and ambiguous. "Nonverbal signals differ from words in that several can be emitted spontaneously with the same signal having different meanings according to which other signals are combined with it, and, secondly, in many cases people are not consciously aware of the nonverbal signals they produce in detail and cannot describe them accurately or name them…this means that nonverbal signals are less

attributable than words and can be used to get a message or attitude across which would not be acceptable if conveyed in speech" (pp.5).

There is also a claim that gestural information is even more important than the verbal (Morris, 1979). One feature of gestural visual imagery is that it can present simultaneous information to convey meaning (Goldin-Meadow, 2003a). Instead, speech is sequential and the language is one-dimensional (phonemes, words, phrases, sentences). Thus, the listener mainly attends more to the visual (80%) than the verbal channel (Ribeiro, 1994). Even though speech and gestures contribute identical information, the visual representation aids faster processing. Studies show that when the nonverbal variable is present, the content of the message has an impact on the receiver, while when the verbal channel is used alone, the content turns out to be irrelevant (Davis, 1975). Although hand gestures and their visual representation of meaning have a major impact, they remain hidden and greatly underestimated in communication (McNeill, 1992). Thus, there is a need to augment their visibility.

Gestural Background

Hand gestures reveal thoughts relying on visual imagery. When communicating with gestures, the cognitive effort for the receiver is reduced. They help to retrieve words faster from memory and provide routes to new thoughts. However, gestures encode complex messages that match what the receiver has stored in other type of body language serves as contextual information that might reduce the ambiguous meaning of a hand gesture.

The level of interest a listener has toward a speaker can be conveyed in posture (Neill, 1991). The body comes forward to represent interest and excitement. The degree of this movement is determined by the cause of excitement (Ott, 1902). Backward movement communicates fear, horror, defiance, etc.

Also, Ott identifies that there are three altitude zones of the arms and hands as a unit: elevated (on this plane we place the good, exalted, grand, dreams, vision, and superstitions); horizontal (on this plane we place all that is on our

own level); and downward (all the bad, worthless, mean). This is much of what McNeill (1992) refers to as *gesture space*. The gestural space can be visualized with concentric squares starting at the front-center of the chest. As such, the space is divided into upper, center and lower, as well as right and left. He states that different gestures occupy different spaces. However, the literature does not mention what gesture correlates to what space.

Finally, "the elbow is the thermometer of the affections and self-will": close elbows represent meanness, selfishness; normal position represents calmness and lifted out represents tenderness (Ott, 1902 p.26).

A Hand Gesture Vocabulary

Diverse literature has been written regarding a dictionary or vocabulary of gestures (Bäuml & Bäuml, 1975). The most recent gesture vocabulary has been conceived by Armstrong and Wagner (2003). They offer a diverse guide to gestures and the different contexts in which they are performed. They have defined gestures as any body movement associated with meaning. In their assessment of gestures, they have analyzed gestures within different categories, including **usage and origins**: how the gesture is used and its roots; **region**: where the gesture is mostly used; **environment**: what situations the gesture is used; **execution**: step-by-step how the gesture is developed; and the **variation of performance**: how the same gesture varies in meanings and performance. They have identified gestures within seven categories that are communicative of behavior: arrival and departure, approval, disapproval, mating, offensive and profane, just for emphasis, and non-words needed. The authors offer an extensive list of gestures covering the aforementioned five-point analyses.

Since 1997, Givens (2005) has developed a private, non-profit research center for nonverbal studies. His center's research investigations are the product of a dictionary of gestures that is one of the most extensive online dictionaries of nonverbal studies.

The gesture vocabulary in Neill (1991) offers information and interpretations of a wide-range of types of gestures, such as awareness of dominance,

certainty, showing positive and negative attention, conveying enthusiasm, showing interest and friendliness. It offers a great account of information of how those actions maybe be represented with gestures. As we have seen earlier, for the researcher, gestures include the body language, as well as hand movement, such as the gesture of looking around that may signal a lack of comprehension. Richmond (1992) develops a workbook to understand the role of nonverbal behavior. The workbook is designed to expand the knowledge about nonverbal behavior and strategies to improve the interaction communication in the classroom environment. The workbook is designed in assessment units. In general the author analyzes the nonverbal communication interaction in the classroom under the following levels:

a. The amount, type, role and relevance of nonverbal vs. verbal interaction communication
b. The impact and value of physical appearance – dress codes, kinesics (gestures/postures/movements)
c. The impact and value of facial expressions
d. The impact and value of the environment – seating arrangements, lighting, temperature, sound, color, smell, time
e. The impact and value of personal space – territorial behavior

As can be seen, the analysis includes a wide range of nonverbal information, such as appearance, body orientation, posture, gestures, touch, space, clothing, eye behavior, seating, time, silence, vocalist and environment. Even though an extensive list of gestures exists, none of the literature indicates a vocabulary of hand gestures produced in the classroom environment. However, of the rich list of gesture analysis and taxonomy, none were observed in the classroom, leaving open the opportunity for this researcher to conduct studies in the identification of a gesture vocabulary grounded in learning environments.

Research Inquiry from Computer Science

Human Computer Interaction

"Human –Computer Interaction (or HCI) is, put simply, the study of people, computer technology and the ways these influence each other" (Dix, 1998 p.xv). The interest is to build effective user interfaces by understanding the processes, dialogs and actions through which the human user employs and interacts with the computer. As such, HCI studies the design, implementation and evaluation of interactive computing systems. HCI assumes that there is intelligence in both information systems: the human and the computer. As such, the HCI study region lies in the intersection of social sciences, technology, computer science and design (Caroll, 1997). For example, there is a need to understand human cognitive processes, the social value of the product, its hardware technology and its usability. Thus, the problem of HCI relies in not only understanding the human user, but also to translate this understanding into effective and affective interfaces for communication with computers.

In the past, much of the concentration of HCI was placed on the efficacy of input devices (pointing devices) and the usability of information (e.g. menus). However, as technology has become more networked and pervasive (ubiquitous or transparent), HCI has shifted its foundations. Since the interaction is no longer confined to a desktop, the special role of HCI is to better understand interaction technologies of a networked world of computer-mediated communications (Hollan, 2000). The current belief is that minds are not passive, but embodied, in which the human body and the material world (the interface) make a centrally joined world, rather than peripheral ones; and that social organization and interactions determine the way information flows though a group.

Interaction Paradigms

> *"Society has been always shared more by the nature of the media by which men communicate than by the content of communication"(McLuhan, 1964)*

There are many ways to communicate with and through computers. This communication process occurs mainly via the use of some kind of input (e.g. a pointing device) and output devices (e.g. a monitor). The nature of input devices are described by Card (1991) as: "part of the means used to engage in dialogue with a machine…unlike human-human communication, the dialogue is between fundamentally dissimilar agents, in terms of both perception and processing" (p.101). However, the model of interaction indicates that a user's output also becomes the computer's input (Norman, 1990). Generally, the interface operates by having the input from the human end occurring though the senses, and respectively, the output through the motor systems. From the system perspective, input occurs through the use of devices, such as keyboards, and output through the use of display devices. Thus, both human and system devices operate as a medium for the interface.

In the interaction communication area, two major models can be encountered: user-centered models and system-centered models. The difference between the two is how the communication between humans and computers is established. The system-centered model demands the user to adapt to the limitations of the computer system. Usually, this can be referred to as intrusive technology. User-centered technologies, on the other hand, make the computer interface less intrusive in our daily interaction with computers. This latter model creates the foundation for a more naturalistic way to interact with computers, in which the user does not use too much cognitive effort to interact with the system. The focus relies on the content, rather than the input mechanism interaction. Thus, the model incorporates computer-mediated technologies within a less conscious use of tools, promoting more *unmediated* interactions.

Intelligent User Interfaces

> *"What is needed is a science of human-computer communication that establishes a framework for multimodal "language" and "dialog", much like the framework we have evolved for spoken exchange…the development of Human-Centered Information Systems." (Sebe et al., 2004)*

As computer systems become more intelligent and minimal, the environment becomes the medium for the interface. The first researcher interested in studying the environment, as the interface, was Weiser (1991). In his widely accepted article - "The Computer of the 21st Century," the interest relied on having computers adapting systems in the environment to communicate with humans. From that point on, the focus was to shift to giving computers the equivalent of the human senses, technically referred to as perceptual user interfaces (Turk & Robertson, 2000) and intelligent user interfaces (Maybury & Wahlster, 1998). Pervasive computing, context aware-systems, gesture/gaze recognition systems and voice recognition are all examples of branches of HCI with the use of natural language interfaces. In fact, the system is intelligent enough to sense the human, and the human can naturally use intelligent systems to interface with computers, although some systems require the user to wear portable devices to be sensible. An excellent example is Project Oxygen developed at MIT (MIT, 2003a). The argument for the project is that computers have actually forced us to serve them. They argue for pervasive, embedded, nomadic and adaptable human-computer interaction.

Computer Vision

Vision is by no means one of the most powerful channels in the input interface. Giving computers the ability to exploit vision as the main communication channel with humans is referred to as computer vision, and more specifically Vision-Based Interfaces (VBI) (Porta, 2002). To do so, cameras are used in a non-invasive way as input devices. The idea is that cameras are able to detect the human (movement) and identify the movement (recognition) in order to control the interface. As I stated earlier, there are countless numbers of human movements that can be accounted for by the

application of VBI in the computer interface. Head tracking, body tracking, face recognition, hand recognition and eye tracking are some of the resulting applications.

Bolt (1980) was one of the first researchers to explore the use of gestures in the computer interface. The project "Put-that-there" used the integration of verbal and pointing gestures to control projected visual interfaces. This project had a major impact in the computer science community, in that it has served as a model and foundation for later projects. The Vision Modeling Group at MIT started in 1987, led by Alex Pentland and Ted Adelson, with the purpose of studying the problems of vision, scene modeling and human perception (MIT, 2003b). The most significant project ALIVE (Artificial Life Interactive Video Environment) integrates the use of gestures captured by video cameras to command virtual avatars. What characterizes these projects is the incorporation of hand gestures in the interface with the use of computer vision that is VBI. At present, there is extensive literature on the use of hand gestures and VBI (Bretzner et al., 2001; Cipolla & Pentland, 1998; Guangqi, 2004; Porta, 2002; Sebe et al., 2004; Wachsmuth & Fröhlich, 1998; Yang & Ahuja, 2001). Hand gesture VBI research concentrates on developing pointing/drawing devices, navigation of virtual worlds, remote controls either with or without the presence of visual interfaces, and sign language. The principal characteristics of the projects are in testing the use of different image processing mechanisms, such as skin color, shape, static gestures or dynamic gestures; and the number of cameras used in the methods, such as monocular vision or stereovision. Thus, the concentration relies on having the system positively respond to task commands, Braffort (1999) states that gestures can be studied either as a form of expressive movements or as a specific form of symbolic actions. Braffort indicates that in the context of human-computer interaction the latter form seems the most interesting one, but in the future it might well be that spontaneous expressive gesture input will be significant to study for computers operating in real-time interaction.

Research on hand gestures has indicated the need to understand the qualitative aspects of human discourse for computer applications (Quek et al., 2002), since gestures are effective means of communication within computer applications (Kurtenbach & Hulteen, 1990). As such, current literature

indicates a need for focusing on the success of the system, rather than developing meaningful content and applications. Moreover, the literature has greatly ignored the issue of the content of hand gestures in relation with specific contexts in learning environments. However, the motivation of all the projects relied on the need of more natural ways to communicate with computers, the argument being that the computer science community has focused mainly on single users, rather than using gestures for collaborative work, indeed not incorporating a collaborative component of human-to-human interaction mediated by computers. Not only should research be conducted on ways to naturalize the interface, but also on the methods of how human-to-human computer-mediated communication occurs.

Computer-Mediated Communication

As much as people use computers to perform tasks, they also use them to interact with other individuals: technically this is called Computer-Mediated Communication (CMC). The framework to understand how people communicate through the use of computers can be summarized with the time/space matrix (Dix, 1998). The matrix specifies the variables of synchronous and asynchronous interactions against the user location, which can be the same location or remote. Same location and synchronous interaction is what we encounter in face-to-face communication. The opposite is asynchronous remote communication, of which e-mailing is an example. This matrix represents a common language for communities interested in developing interactions that support collaboration. These groups are technically called Computer Supportive Collaborative Work (CSCW), or Groupware. However, recently the name Social Computing has been rapidly increasing in use (IBM, 2005; Microsoft, 2005).

Regardless of the name, the purpose is to research and develop software that contributes to compelling and effective social interactions, with a focus on user-centered design processes and rapid prototyping. Moreover, these groups state that the need lies in understanding how making people and their activities, visible to one another, can make social processes more viable online, and serve as a generative resource for supporting fluid group activity. CMC relies on interactive systems that support group communication and

collaboration. Moreover, research in CMC explores new ways to communicate effectively. An important variable to support compelling interactions with computers is to incorporate the variable of emotion. Literature indicates several researchers are interested in understanding affection in the interface (Paiva, 2000; Picard, 1997, 2000). Understanding affective communication is an approach to naturalizing and enhancing human-to-human communication through computers. Emotions are important factors in problem-solving capabilities and intelligence.

In current computer-mediated communication, user input is transparent in the interface. The computer becomes the catalyst of the human communication, in which the visibility of hand gestures and its expressive, emotional and cognitive capabilities are lost. As IBM (2005) explains, "even when others are clearly present -- as in a chat room or on a conference call -- it is difficult to see who is present, who is paying attention, or who wishes to speak. Things that require little effort in face-to-face settings -- taking turns when speaking; noticing when someone has a question; seeing who is responding to whom -- require a lot of effort in online settings, if they are possible at all." Bringing gestures to a computer-mediated environment is one of the first steps in making the interface more humane, visible and fluid by operating on the inherent variables of emotion and cognition. In other words, the idea is to start developing unmediated environments by reducing the filtering of spontaneous meaningful data, where the media and medium become a unified channel.

Research Inquiry from Education

What is Distance Education?

There are different definitions of distance learning. The most complete definition has been written by the Institutional Technology Council in which they define it as "the process of extending learning, or delivering institutional resource-sharing opportunities, to locations away from a classroom, building or site, to another classroom, building or site by using video, audio, computer, multimedia communications or some combination of these with other traditional delivery methods" (ITC, 2004). Regardless of the different

definitions, any definition of Distance Education (DE) should have four main components: it should be institution based; there must be a separation between teacher and students; it should use interactive telecommunications (asynchronous - synchronous); and it should include the sharing of any video-data-voice within educational reasons (Simonson, 2000). Simonson explains that there are many theoretical frameworks in which to study Distance Education, such as autonomy in the learning experience. However, the relevance of interaction and communication dictates the student's emotional involvement, thus the learning experience.

The communication model is similar to that previously explained by Dix's CMC, the matrix of space and time, which has also been designed by Caldeway. There are two fields of experience: sender and receiver linked with a mechanism channel. In DE, the mechanism channel is the media. The media is used to communicate with distant learners, either synchronously or asynchronously. In both cases, the media extends the senses of the learner (encode). When the DE learner receives the message, it also must be decoded. Thus, a successful communication is when both sender and receiver have the same idea or understanding of the message (Simonson, 2000). This is what is referred to as communication interaction based on feedback.

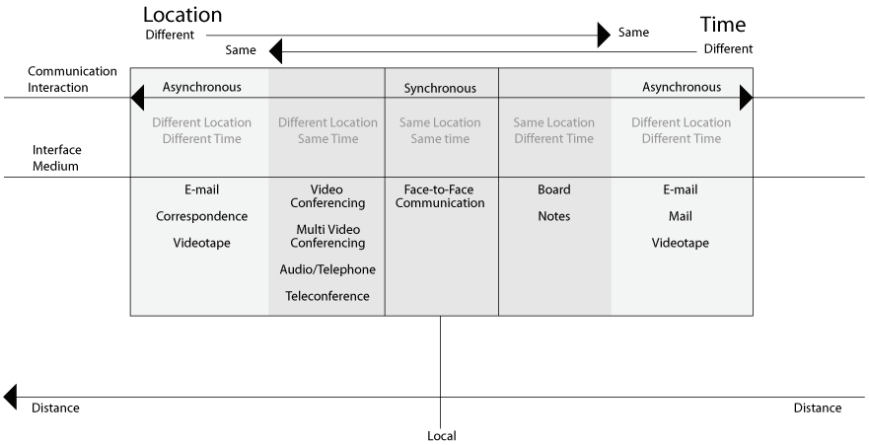

Figure 1: Distance Education Continuum

Technology in Education Indicators

Distance Education programs have been continuously expanding. For example, between 2002-2003 54,000 online courses were offered in 1,680 institutions (Moore, 2002). Also, research on the topic of students' adoption of and performance in education delivered at a distance has been conducted. Literature indicates that there is no significant difference, in that learning can be equally effective for online and face-to-face learners (Moore, 2002; Neuhauser, 2002). Moreover, learning with computer technologies can have a positive effect (Schacter, 1999). Instructional technologies have proven to be more effective in improving the learning of students in college courses – students taught with and without computer help were compared (Kulik, 1994). The findings suggest that students who use computers learn more, faster and have positive attitudes towards learning. Kulik argues that the use of computers in learning environments is an effective means to improve student achievement. Therefore, one can say that the use of technology can improve student learning. However, as Wenglinsky indicates, the computer technology used does not matter, if it promotes achievement; what matters depends on how it is used (Wenglinsky, 1998).

Online Environment Communication Interactions

> *"Technology is an enabler, both a tool that can be used to construct a knowledge environment and a channel for human interaction that functions more effectively when seamlessly integrated into the environment…in a well planned collaborative experience mediated by technology, the collaborative strategy provides the process and structure for social interaction and technology provides the channels and modalities for communication"*
> *(Comeaux, p.xviii)*

When educators discuss the need to integrate technology in education, they are basically speaking of hardware and software implementations and little about the pedagogy (Watts, 2003). Teaching and learning with interactive computer technologies are increasing and becoming more supported by

major institutions, as well as the concern of providing effective communication interactions that support collaboration and learning increases. The purpose for Comeaux (2000) is to provide a comprehensive understanding of the human communication issues that must be addressed, when interactive technologies are involved in education. In her book, Leftwich (2000) states that communication and collaboration are essential for educational programs to succeed, and they increase the potential for learning. In other words, focusing on building collaboration and group interaction may be more important than focusing on individual participation (Simonson, 2000). Comeaux indicates that collaboration is challenged by the difficulties in online environments, such as the lack of spontaneous verbal and nonverbal feedback, constrained both by timing and modality of feedback opportunities. As such, she summarizes that traditional face-to-face and distance classrooms are colliding, where the richness of the face-to-face nonverbal communication is missing and highly needed to engage the student in seamless mediated communication. This later thought has been claimed in DE with the requirement of simultaneous viewing, such as the use of synchronous video conferencing, and the better share of space for group interaction in the near future implications of distance learning (NSB, 2002).

In the same account, Hentea (et al, 2004) analyzes current and future expectations of Distance Education, which states that not only is cooperation among students difficult at a distance, but real-time interaction via emerging technologies is essential. Hentea suggests that poor communication is a concern in Distance Education, where much of the value of the learning experience is compromised. She further suggests that the educational experience is even more compromised due to the absence of body language, as sensorial facilitators of communication. Students lose the capability of assessing and sensing actions and reactions. Furthermore, misunderstandings can increase because of the absence of non-verbal cues.

Moallem (2000) demonstrates that the adopting of current technological tools (forums, chat rooms, e-mail, file sharing, etc) offers limited interaction and collaborative communication and is mainly slow in the sense that a conversation that could have happened in 30 minutes face-to-face ends up to

be 3 times longer. Therefore, he argues that communication is neither appropriate nor responsive to current communication technologies. The argument is that for DE communication technologies, feedback is necessary to increase students' willingness to participate in the discussion and interaction. Moallem (2000) indicates that the immediacy of behavior (where behaviors are understood to enhance the closeness to and nonverbal interaction with others) affects students' motivation in carrying on the discussion and discourse. Moreover, Moore (2002) suggests that not only does the feeling of dissatisfaction come, when there is a lack of prompt feedback, but also when there are not mechanisms to express emotions. He states that learner satisfaction is correlated with affective outcomes linked to social presence influencing cognitive presence, that is, cognitive learning outcomes. The overall assessment is that the interaction mechanism and attributes will promote learning, but will affect the learning experience through more inclusive, authentic and motivational mechanisms, and hopefully will enrich and improve the learning outcome.

Participation Assessment in Education

Online evaluation can be challenging, especially, when evaluating work from discussion groups. Currently, professors need to develop a self-assessment tool, which measures (quantitatively) the frequency of e-mail contributions and the quality of the responses (Dexter, 2003). This latter method is difficult and time consuming and only applies to asynchronous CMC, such as e-mails. However, no literature was found on the topic of assessing participation in online learning environments. This lack brings to light the significance of this project to have the design intervention to find alternative ways to visually model classroom cognitive behavior in participation.

Gestures in Online Learning Environments

Video-conferencing has been around for some time and offers the opportunity to establish face-to-face communication mediated by computers. This is a synchronous remote interaction model. In other words, two or more people are remotely located and can establish a conversation occurring in real time (same time) with the use of video cameras. One

problem of this system is that the communication is connected with a small field of view with reduced image quality, in which it is hard to see the gestural language (Dix, 1998). The gestural input becomes irrelevant, generating a lack of reciprocity compared to face-to-face communication. As Huber (2000) indicates - "for me to feel comfortable with my students, I needed to be able to see and hear clearly their reactions to a degree not available with the technology" (pp.119). Moreover, he further states that the interaction visual space becomes complex with a lack of fluidity in the communication process, when the many people involved create complexity in the classroom. As such, the argument is that simultaneous viewing that is similar to face-to-face communication through the use of synchronous video-conferencing is not enough, if the message cannot be readable or understood. Thus, viewing is not enough, rather understanding the transaction and collaboration, as a group, by the gestural visual channel is of importance.

Chapter Conclusion

Summary of Motivations and Concerns

This chapter explains the major motivations of conducting this research from a multidisciplinary focus, which can be summarized as follows:

1. The need for a paradigm shift in Information Design
2. Focus on designing meaning-making (cognitive and affective) tools
3. Gestures are natural powerful devices that facilitate interaction collaboration in a group and promote learning
4. Gestures should be studied/visualized in context
5. Emergent CMC model providing computers with vision
6. DE need for more fluid and rapid interactive mechanisms

In general, this chapter addressed non-verbal Information as a potential tool for transferring meaning, inherent products of the human being that can be used as interfaces with the use of vision interfaces. The information design discipline can intervene in the process of making a visible grammar from gestures- an accessible and usable communication tool. Moreover, the use of hand gestural input as a natural language interface is a close step towards

simulating face-to-face communication for unmediated interactions with computers. As stated earlier, hand gesture computer applications have mainly focused on the use of the human hand gesture to perform more as manipulator, rather than an expressive and informative tool, without even identifying direct applications, such as classroom environments. Distance Education can potentially benefit from alternative effective communication technologies that support collaboration and participation in a group that principally relies on prompt feedback. Video-conferencing, as it currently is, minimizes the opportunity of reading human intentions in discourse due to the lack of visibility of gestures as regulators of conversation from the natural face-to-face situation. The point is to avoid people relying on their *intuition* as inferential mechanisms during the exchange of information. Video-conferencing supports viewing of the individual, in which gestures can support a determinant role in creating a more understandable process of information exchange from the communication. Gestures and visibility might augment the information space. For example, many people can gesture at once in learning environments, as opposed to many people speaking at once. A small hand gesture can be a powerful, reliable, cognitive and affective tool to facilitate communication. There is a need to add a visual dimension lost in the computer world (all interfaces reduce to single dimensions) by increasing the spectrum (augmenting visibility) of people's behavior in CMC. Moreover, visualizing nonverbal behavior is the first step towards studying potential tools revealing human intentions. DE demands systems for assessing student participation during online classes, such as today's assessment of the many e-mails sent to professors. Thus, there is a benefit in creating tools that can aid the process of measuring online participation. Beyond aspects directly applied in this study, there is a need to start creating tools that can smooth the transition across cultures, a predictable international aspect for Distance Education and technology. These tools include: visualizing the manner in which people communicate with one another, with the purpose of providing contextual information for future cross-cultural applications; developing systems other than teleconferencing that support translations for more natural, humane interactions of several users communicating through computers; and promoting universally effective systems that are inclusive, integrative and more importantly, responsive across users.

Chapter 4

Theoretical Framework

This chapter covers the aims, rationale, background and overall design of the investigation. The choice of design paradigm and conceptual relationships are explained.

A Naturalistic Approach

> *"What, then, is constructionism? It is the view that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context" (Crotty, 1998 p.42)*

Four essential elements are integrated into developing the research: the epistemology that informs the theoretical perspective; the theoretical perspective that lies behind the methodology in question; the methodology that governs the choice of methods; and the methods that best answer the research questions (Crotty, 1998).

The epistemological foundation of this research is constructionist, as the rationale for inquiry and most basic ground to understand and organize reality. The belief relies on the fact that reality is not discovered, but constructed. The construction of reality emerges from social interaction.

In the scientific world, different terms are used to refer to the underlying assumptions or belief for conducting research. Many call these sets of assumptions a theoretical framework, but it can also be referred to as worldviews or paradigms (Babbie, 1986) . Literally, theoretical frameworks are general frameworks and *points from which to view* (Johnson, Ashworth, & Dandeker, 1984).

Babbie (1986) addresses fundamental philosophical and methodological issues involved in the scientific study of human beings. He defines a paradigm as "a fundamental model or system for understanding things" (p.29). In other words, he uses an example that a paradigm is a lens that we use to see reality. In understanding human beings, he defines three lenses to understand reality: interactionist, structural/functional and conflict paradigms.

The interactionist model states that human life consists of creating shared meaning through interactions. In other words, human emotion and cognition are shared to create meaning and define a reality in a communal space. Thus, in creating the reality in learning environments, this study assumes the following points as points from which to view:

- Realities are created through interaction, thus learning emerges from the interaction and knowledge comes from a social product.
- Reality is voluntary, thus interaction communication is not a fixed product, where students are active participants in the creation of meaning.
- Reality is contextual, thus learning is contextual; where the experience is collaborative, and teaching and learning are reciprocal in the local shared environment.

In learning environments, meaning emerges as the collective shared experience. We experience before we understand. Therefore, we can cause experience by sensing and facilitating the physical input of information, which can be defined as stimulation. The inclusion or application of metaphors is used to facilitate/stimulate change in the meaning of experience. The theory is that learning should be stimulated and facilitated through interaction, and the emotional involvement enhances that experience.

Rationale of the Study

Based on the literature in the earlier chapter, the research theoretical framework relies on the assumptions that:

- Communication interaction is the main mechanism to a successful learning experience.
- Interaction with and through computers should be user-centered (the system adapts to the user: vision-based interfaces).
- Nonverbal channels of information augment the information space in communication.
- Individuals have a natural ability for gesturing (spontaneous).
- Gestures are context sensitive; the same gesture can hold different meaning across contexts.
- Knowledge is shared/constructed in context, a social constructionist approach.
- Gestures reveal thinking processes.
- Thinking occurs through interaction with individuals.
- Understanding/learning is physical and embodied.
- Information design should shift focus from designing fixed presentations of information to designing cognitive tools.
- Visualization facilitates the transaction of information between sender and receiver.

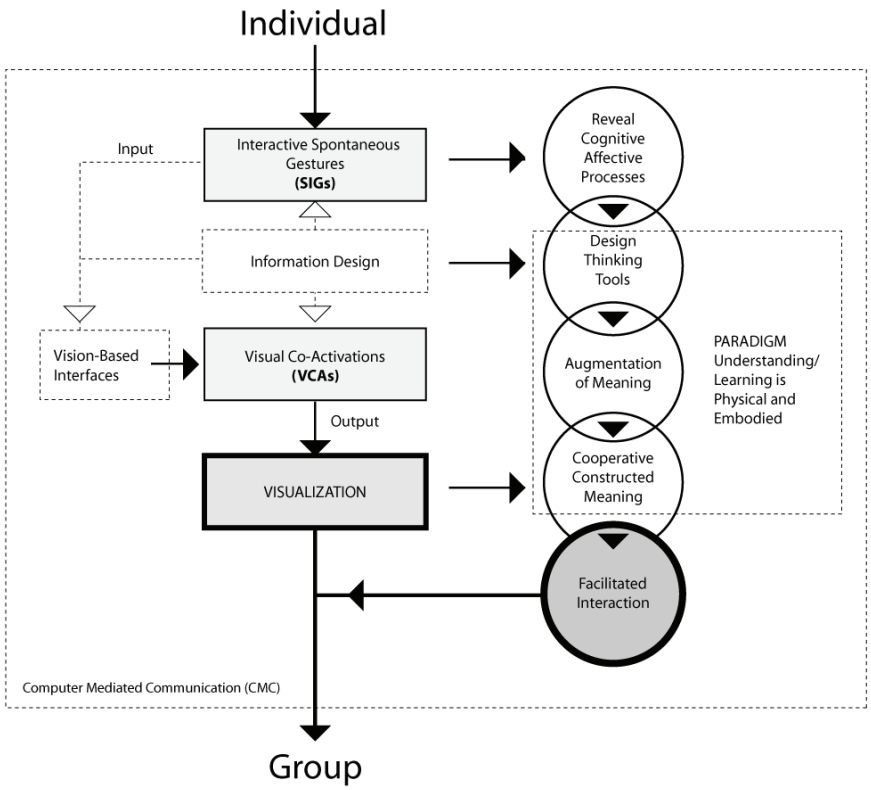

Figure 2: Theoretical Framework

As earlier stated, Distance Education programs are continuously and rapidly expanding, as are the claims for better mechanisms of interaction. One of the major needs is to resemble in computers the efficiency of face-to-face communication, where hand gestures may aid the interaction. Multi-video conferencing supports simultaneous viewing in a more naturalistic manner of interaction with computers. However, viewing is not enough, but rather understanding of the communication as a group. Spontaneous hand gestures are powerful vehicles of reliable nonverbal information that can reveal cognitive and affective behavior. Moreover, the nonverbal channel offers a visual dimension that in a majority of the cases cannot be reduced in the verbal channel. Multi-video conferencing, as it currently stands, minimizes the opportunity of reading human intentions in discourse due to the lack of visibility of gestures, as regulators of conversation from the natural face-to-face situation. Several people are reduced to small windows on the computer

screen. Therefore, the information space and the role of gestures are minimized to small accountings.

There is a need to add a visual dimension, lost within the computer world, in which all interfaces are reduced to single dimensions. As such, many people can gesture at once in learning environments, as opposed to many people speaking at once. Linking literature from cognitive science, visualization and nonverbal information brings about the foundation for this research goal to create the augmentation of meaning by stressing the content of the gesture, as a functional mediator of communication. The goal is to concentrate on nonverbal information designs as cognitive artifacts, with the intention of later proposing meaning-making tools to bridge the physical forms with facilitated comprehension (to aid representation and understanding of a message). Visualization can function as an augmentation of meaning by stressing the content of the gesture, as a functional mediator of group communication.

The model of this study is towards avoiding people relying on their *intuition* as inferential mechanisms, during the exchange of information, but rather augmenting the meaning of gestures through visualization in order to amplify the information space. In other words, the purpose is to increase the spectrum (augmenting visibility) of people's behavior in computer-mediated communications. This model proposes the first steps towards studying potential tools for revealing human intentions. Moreover, studying the role of gestures and the augmentation of their meaning are the steps towards designing mechanisms that help people participate and collaborate as a group in online learning environments. Hopefully, the outcomes could be used for professors to assess student participation in the online classroom.

Research Questions

This research aims not only to identify the potential SIGs to be used, as input devices for CMC, but also to measure how their visual co-activation might facilitate participation and feedback for distance learning. Therefore, this study attempts to answer the following research question:

How can the use of VCAs of SIGs demonstrate participation and facilitate feedback of synchronous interactions in online learning environments?

Subsequent questions to answer involve:

What are the potential spontaneous hand gestures used in participation within learning environments?

What are the visual channels that best represent and facilitate participation and feedback within online learning environments?

Do visual co-activations of gestures augment and promote better means for understanding the message being conveyed?

Design Model for Online Learning Environments

From the aforementioned assumptions/approaches and research questions posed, a research model is proposed with its main goal of converting scientific observational paradigms into an applied discipline, as follows:

1. **Identify gestures produced in context**

The goal is to learn about the pedagogical value of gestures (content and number) that are produced in learning environments, towards a participatory SIGs classification framework for learning environments. This model is exploratory in nature, in which the purpose is to investigate, identify important variables and generate hypotheses of little understood phenomena (Marshall & Rossman, 1989). Since, the goal is to understand the subject under study, a descriptive study is carried out (Polya, 1984). Usually, qualitative approaches are used, with the use of field study designs and observational methods for data collection.

The research approach and designs mentioned rely on understanding phenomena in natural settings. Natural settings are appropriate for studies concerned with discovering data.

2. Visualize and test the augmentation of gestures' meaning

The goal is to use design as an intervention/mediation of gestures to augment their meaning through the use of visual representations and test their performance.
This secondary complementary model is predictive in nature, in which the purpose is to test the outcome of a phenomenon and predict the behavior of that phenomenon (Marshall & Rossman, 1989). Since the goal is to test the performance of the subject under study, quantitative research approaches are used (Polya, 1984). For those approaches, experimental designs and survey methods for data collection are usually employed.

Ultimately, as Friedman states, the foundations of conducting research in design are "generating problem areas such as information content that often exceeds the value of physical substance" (pp.6), which would require qualitatively different approaches, involving advanced knowledge in response to the demands of the information society and the knowledge economy (Durling & Friedman, 2000).

Chapter 5

Research Approach: A Mixed Methodological Design

This section covers the research design, methods and systems employed, tools utilized and procedures for the data collection, as well as a justification for these choices.

Overview

The research study uses a mixed methodological approach, technically called a two-phase (Creswell, 1994) and developmental design (Greene et al., 1989). The study combines qualitative and quantitative research methodologies as models for the design of the study.

Purpose

The choice of the methodological approach arises from the purpose of this study. The purpose of this study is to ground and justify the experimental design variables in data found in real-life situations. That is, isolating the variables from real circumstances for examination in experimental studies. Therefore, a sequential, multiple-data collection procedure is suitable for the study to link paradigms, theories and research questions to the methodological focus of this research. There are different multiple-data collection procedures or mixed methodological approaches, such as: triangulation; complimentary; developmentally or sequentially; initiation; and expansion approaches. This research study employs a sequential mixed methodological approach in which both an ethnographic case study relies on qualitative methods, and an experimental study relies on quantitative methods.

In this type of mixed methodological approach, the first method is used sequentially to inform the second method (Creswell, 1994). The idea is to conduct a deductive-driven design process from inductive, emerging qualitative measures. Qualitative studies are conducted first to identify and

describe the phenomena, followed by quantitative studies to measure and control the impact of that phenomena.

> *"The advantage of conducting this approach is that the two paradigms are clearly separate; it also enables the researcher to present thoroughly the paradigm assumptions behind each phase" (Creswell, 1994 p.177)*

Methodological Phases

For a better description and understanding of the use of mixed methodologies, this study is divided into two phases: Phase One focuses on qualitative research and ethnographic methods, which incorporate the use of observation and interview methods; Phase Two focuses on the quantitative research and experimental methods, which include the execution of a pure experimental research design.

Chapter 6

Phase One: Visualizing Nonverbal Communication - A Qualitative Approach

Overview

The purpose of conducting the Phase One research studies is *to collect information about the communicative affordances of gesture and participation in classrooms*. This phase seeks to discover and measure the content and number of meaningful gestures that students are able to produce in a learning environment.

The research methodology documented and collected data through the use of video, photography, questionnaires and interviews with students in a college teleconferencing class, which involved both traditional and distance learning instruction. Not only were ethnographic accounts of gesture in a teleconferencing environment developed, but also a classification of gestures for experimental testing. The study concerned with understanding the qualitative aspects of the content, range, and frequency (towards a classification) of gesture as means of communication that supports and affects the nature and effectiveness of participation. As such, Spontaneous Interactive Gestures (SIGs) are considered as being indicators of level of participation. The interpretation of the non-verbal meaning produced in the *natural* settings of SIGs provides a means for facilitating, engaging and managing interaction in the classroom environment.

Definition of Terms

Affordance refers to "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (Normal, 1990 p.9). Affordances describe and provide clues about how and why things operate in certain ways. As such, the term *gestural affordances* refer to the visual properties of gestures that can determine how and why people interact in participatory ways in the classroom environment.

Content refers to the meaning of gesture in a learning environment. The idea is to understand how the visual properties of gestural affordances are linked to intentional behaviors. The focus of attention is on understanding the information, the *message* and the *meaning* that a gesture is trying to reveal or unfold.

Number refers to the frequency of gestural use in a learning environment. The purpose is to quantify the number of gestures in order to develop a frequency analysis.

Both the content and the number of gestures are collected to facilitate understanding of which of the gestures indicate or encourage participation; this information is used to describe and classify those gestures used in the communicative interaction processes of learning environments.

Proposed Research Paradigm for Phase One: Qualitative Methodological Assumptions

A qualitative research methodology is suitable for studies with the characteristics of Phase One of this study.

In conducting qualitative research, (Creswell, 1994) cites different reasons. First, the nature of the problem is exploratory. The body of literature surrounding the study of how and why gestures are used in college classroom environments is limited. Little has been written about the topic and the population being studied. Therefore, the researcher is mainly interested in discovering phenomena by observation and through interviews, rather than testing on the basis of knowledge from a body of literature that already exists.

Second, an important reason for proposing a qualitative research methodology is the interest in descriptive and inductive data, rather than numeric and deductive data. In the development of human-centered approaches to technology, there is a need to understand and develop concepts and theories from observations of human interaction in specific settings rather than testing highly general hypotheses and or dependent on machine-centered concepts.

Third, in the nature of exploratory research, variables are unknown. Variables and categories emerge from participants through the observations and interviews. The researcher sought to classify and describe gestures by visualizing and identifying the interactive communication variables within the social aspects of groups in the naturally-occurring learning environment, inherent in teleconferencing.

Finally, the context of production is a crucial measure used to explain a phenomenon. Gestures are *context-bound*; the meaning of gestures differs across contexts. Therefore, it is necessary to study the role and nature of gestures unfolding in their natural context - both in local and in remote learning environments. It is also important to understand the occurrence of the nonverbal information across different classroom types.

Ethnographic Studies as a Methodology

> *"What is ethnography?*
> *...In its most characteristic form it involves the ethnographer participating, overtly or covertly, in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are the focus of the research"*
> *(Hammersley & Atkinson, 1995 p.1)*

Ethnographic methods are suitable for this study, since the purpose is discovery; an inductive process for studying how students use gestures (both content and frequency of meaningful gestures) primarily though observations in natural settings, such as the classroom environment. Ethnography brings critical, reflexive and empirical perspectives to the topic of study. In this case, it is gestures in education, with emphasis on the understanding gained from naturally-occurring processes of the *everyday experience*. The ethnographic paradigm advances an emerging design, in which categories are identified during the research process, and patterns and theories developed for understanding are context-bound (Creswell 1994). Therefore, data emerges from the field and the researcher is the main

measuring tool. As such, within this research design, variables are unknown upfront. Rather, they emerge during the collection and interpretation of the data. Collected data is used for the subsequent experimental methodological phase.

The research methodology of Phase One is comprised of different parts. The following sections explain the different qualitative methods of data collection, used across learning environments.

Hypothesis

The researcher does not state a hypothesis upfront (see qualitative methodological assumptions). Rather, it is expected that the phenomenon discovered is, in itself, a hypothesis (Polya, 1984). However, there is a need to anticipate and formulate a list of expectations to justify the need of conducting the fieldwork.

The hypothesis states that the content and frequency of gestures will be better utilized in participation in local classroom environments, than in their distance learning counterparts, due to the shortcomings of the current communication systems used in the latter. Therefore, it is expected that there is more communication participation by the *local site*[1] students than the *remote site*[2] students. It is envisioned that the content and frequency of gestures from the remote site students will be limited and different from those encountered in traditional classroom environments.

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[1] Local site refers to the location of students in one physical classroom, where a group of people meet for educational purposes. See "Sites".

[2] Remote site refers to the dispersed locations of students, connected by communication technologies for meeting as group for educational purposes. See "Sites".

Settings

Description

There are two broad categories for research settings: natural and contrived settings (Polya, 1984). Phase One of the research observes phenomena under natural settings, for the following reasons:

> *"Natural settings offer researchers the unique opportunity to observe people in settings they choose to come to, engaged in activities a contrived settings could not re-create…Natural settings are particularly appropriate for diagnostic studies in which investigators want to find out what is actually going on—what elements, relationships, and dynamics are salient" (Polya, 1984 p.72)*

North Carolina State University (NCSU) will be the primary setting for the study of SIGs in both traditional and distance learning environments. NCSU is a leading university in information technology with a large population of students with high computer literacy, many involved in a diverse number of distance education applications.

Sample Method Selection

The qualitative research study took place in a classroom environment at NCSU on January-February of 2003, with the purpose of conducting observations in real-life situations. The classroom environment was chosen from the NCSU course listing based on four main characteristics: the communication technologies used; the course affiliation; the interaction style; and the class size. The course was not chosen based on a specific discipline. Rather, different departments/disciplines comprised the representative sample, since studying gestures in a particular discipline was not the main focus of this study; but rather, the interaction style of the class was important.

For a course to comprise the representative sample of the qualitative research study, it had to meet the following criteria:

First of all, the selected course should be a Distance Education listing and should use teleconferencing technologies as the primary communication tool. The technologies in use should allow the transfer of audio and video images of the participants in a synchronous manner to link students from different locations into a single, integrated course. The purpose of using this type of course is to cluster the sample and have evidence of how gestures occur simultaneously among groups and individuals, within the same course.

Second, the selected course should be a graduate-level offering. Several reasons support the selection of graduate-level courses. Graduate-level courses tend to be smaller than undergraduate ones, allowing for the participation and discussion among the students to be more dynamic. Graduate students generally are more committed and participatory than undergraduates, since they have chosen to extend their studies. As such, graduate students are more likely to be active and responsive in their course performance, which will benefit the collection of rich and meaningful fieldwork data.

Third, the selected course should incorporate open discussion as the main interaction style. The study is concerned with settings grounded in debate and discussion in which participation is a major component of the instructional strategy. The purpose is to be able to collect data, based on participation interaction.

Finally, the selected course should be small, so that the recording/tracking of student participation interaction will be manageable. Also, having a small number of students allows for more fluid participation. Typically, these types of courses consist of no more than 15 students and meet for 3 hours each week.

Sites

The settings of this study involve a Distance Education course that uses teleconferencing technologies to link students from different locations within a NCSU course and instructor. There are two concepts embedded in this setting: the local site and the remote site. The local site is the physical location

of traditional classroom instruction and interaction (i.e. a classroom environment in which a professor and a number of students meet face-to-face). Remote sites are the physical locations of students, connected to the instructor and other students by communication technologies. The number of students in a remote site can vary, and there can be more than one remote site within the same course.

Teleconferencing Technologies

Teleconferencing technologies are used to facilitate the communication between several groups of people in separate locations via audio, video, and/or computer systems. People at separate locations can meet at the same time without actually leaving their locations. Live transmissions of video and audio signals are transmitted through video cameras and microphones located at a number of sites, and then viewed through TVs at each site, with the purpose of establishing a connection and allowing communication among the sites.

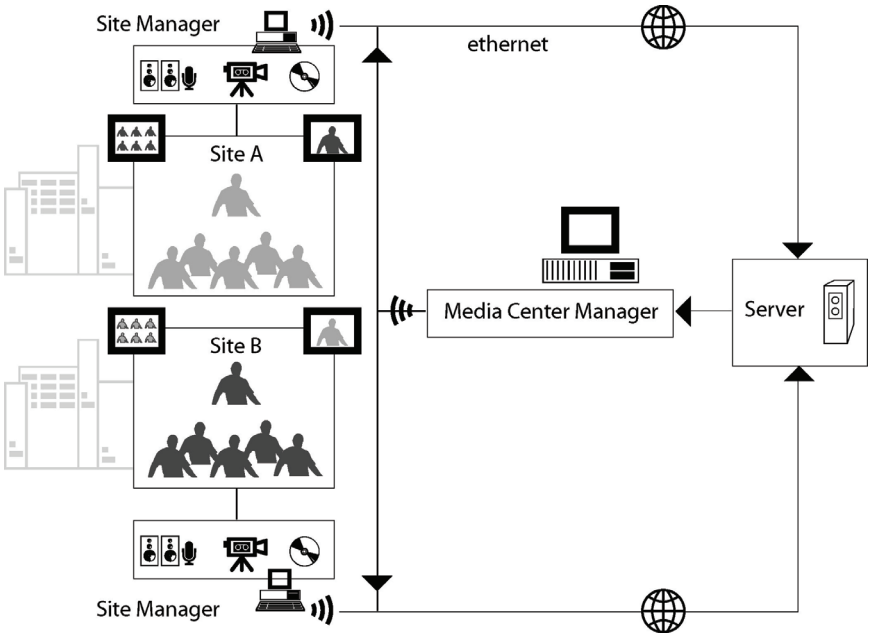

Figure 3: Teleconferencing Technologies

Usually there is a service provider, which acts as a catalyst for the sites. Each site has a technical assistant that operates the local equipment to help establish the communication interaction. The technical assistants direct the video cameras and decide which information to display on the local TVs, as well as the information that is sent to other sites.

Sample: A Teleconferencing Classroom Environment

One teleconferencing graduate course defines the representative sample for conducting fieldwork. Participants involved in the study include a professor and graduate students from both the local and remote sites enrolled in the selected course at NCSU. It is expected that the fieldwork is conducted with a maximum number of 15 people.

Entry to the Research Field

Before approaching the field in order to conduct participant observation, the research proposal is sent to the Institutional Review Board (IRB) at NCSU, in order to have a formally approved application, qualifying the researcher to conduct research in the selected course. The IRB acts on behalf of the human subjects that might be involved in the research projects, and its mission is stated as follows:

> *"The Mission of the Institutional Review Board for the Protection of Human Subjects in Research (IRB) is three-fold: First, to protect the rights and welfare of human research subjects through project review. Second, to foster compliance with institutional policy and federal regulations by facilitating institutional personnel's efforts in utilizing living human subjects for research, education and other scholarly pursuits that are systematically designed and endeavoring to contribute to generalizable knowledge. Third, to provide education to institutional personnel on the ethical use of human subjects. Helping scientists and instructors to be stellar stewards of the trust of our human subjects is of paramount concern"*
> *(IRB, 2005)*

Upon IRB request, an Informed Consent Form is delivered to each of the participants in the field prior to conducting observations. The participants are informed about confidentiality and his/her anonymity in the study, in case of publication of the collected data in the study.

Fieldwork Methods for Collecting Data

The qualitative research study involves fieldwork, in the selected course settings at NCSU. There are different methods used in conducting fieldwork, specifically when human subjects are involved. Among these methods are: participant observation as an observer; participant observation as a participant observer; historical documentation; recollection of field notes, journals, film, photography and/or other visual methods; open interviews; surveys; and focus groups. The selection of methods depends on the type of research questions and the type of sample. This study is based on two fieldwork methods: participant observation and semi-open interviews.

Participant observations are conducted with the purpose of determining the content and frequency of meaningful gestures employed by students in the learning environment; observing the naturally occurring gestures in student-to-student interactions, during the length of the selected course. The researcher participates (as an observer) by taking notes. The researcher is situated in the settings but does not interact, influence or condition the classroom performance.

Interviews are conducted with students involved in the selected course in order to better understand the content and relevance of his/her gestures in the learning environment. These interviews are also used to establish the validity and reliability of observational data.

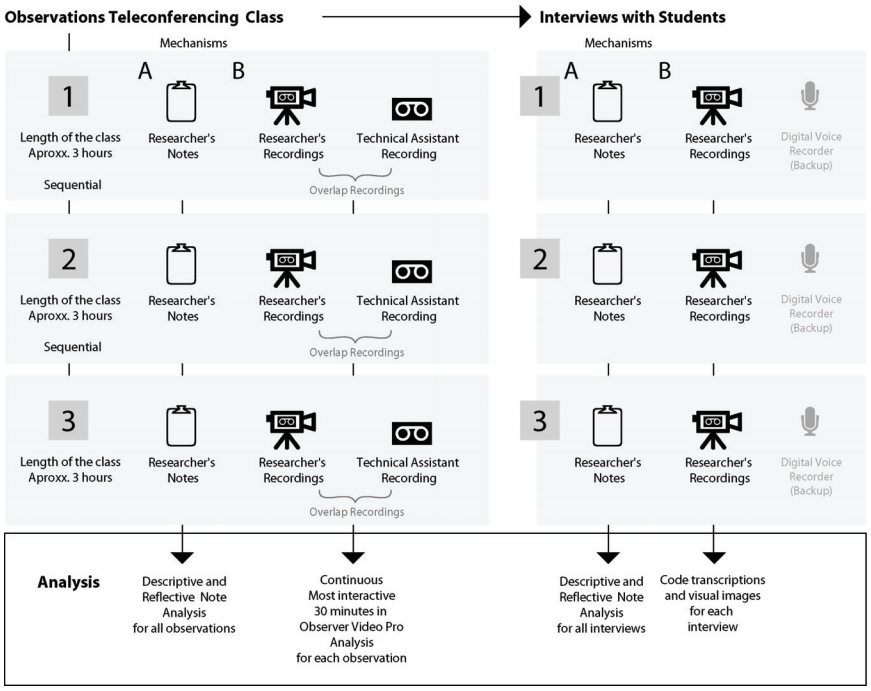

Figure 4: Qualitative Methodology

Observations and Recordings in the Classroom Environment

Participant observations are focused on the student-to-student interactions and the gestures. A total of three course sessions are observed. Participant observations are conducted for the entire session. During the observations, two mechanisms for recollection of data are utilized in order to have later access for editing: video recordings and researcher's notes.

Video recordings are used in the observations. There are three main purposes for using video recording equipment. First, it is possible to obtain a valid recovery of the real-life situation related to how gestures are used during the course session; such data is suitable for the qualitative research analysis. Second, the purpose of this research is to visually record the gestures of the participant, for later access and analysis. Third, the video data can be edited into meaningful accounts that best represent the use of gestures in context with the use of a software tool. These smaller accounts can then be

deconstructed more easily for analysis of the content and frequency of gestures.

Observations are preserved with two video recordings per session: one produced by the researcher and the other by a technical assistant in charge of communication systems in distance education courses. That is, a total of six video recordings are used for data analysis over the three sessions.

A digital video recorder, located in a discrete corner of the room at the local site, is used by the researcher to record not only the local students in the class, but also the images of remote students displayed on the TVs as viewed by the local students. The other recording is conducted in the same site and at the same time, but is operated by a NC State University technical assistant, who manages several video cameras at the local site, as well as the reception of images and sounds of the remote students. A videotape of each class is produced by the technical assistant, and this tape forms part of a library of courses offered in Distance Education by the institution. Together these two video recordings form a complete recovery of the real-life situation and how gestures are used across learning experiences.

At the same time, written notes are taken each session by the researcher. The research notes help in developing a better understanding of the observational data. Information about each behavior is recorded by the researcher, as it is observed, for the length of the observation.

A form for recording the information of each observation is employed by the researcher. This form is a single page with enough space to create demographic, descriptive and reflective notes. Descriptive notes are useful for capturing physical settings, activities that occur through time, and behaviors of members. Reflective notes are useful for relating the researcher's thoughts on a particular activity/behavior of the participants, during the observation. Both mechanisms allow for a complete recovery of observations and analysis of naturally occurring phenomena.

The Researcher's Role

The researcher acts as a complete observer. The researcher is situated in the field for the purpose of observing the participants and does not participate nor engage in any of the interactions occurring in the classroom. This method is useful, since the researcher becomes unnoticeable and the participants do not feel uncomfortable during observation. In other words, being a complete observer does not affect the rapport of participants, during observation.

Face-to-Face Interviews

Besides the participant observations, interviews are also conducted. Conducting interviews helps to reduce bias by providing indirect observations through the views of the interviewees (Creswell, 1994). Unlike phone interviews or group interviews, face-to-face interviews allow the researcher to ask different questions and moderate the length of interview, according to the interviewee feedback. Also, face-to-face interviews allow one to better understand the phenomena under study. Face-to-face interviews are especially suitable for this study, in which the researcher is trying to understand the communicative intent or purpose of gestures. As for the observations, the researcher makes use of forms for the interviews with the purpose of covering a variety of topics (see Appendix A).

The protocol for conducting an interview includes four main sections: the introduction; the descriptive/demographic notes; the open-ended questionnaire; and the closure (see Appendix A).

In the introduction, the participant is greeted and the purpose of the project is explained, as well as the length of the interview, the type of questions involved and the confidentiality of participation in the study. Also, the participant is given a Consent Form as approved by the IRB (see earlier section). The participant is required to sign the Consent Form as proof of his/her willingness to participate. If the participant does not agree with the items described in the Consent Form, then the interview is not performed.

During the description section of the interview, the start time of the interview is recorded, and an overall assessment of the subject (i.e. mood, clothing, position, etc) is made.

A questionnaire section is dedicated to a series of open-ended questions in which the participant is asked his/her opinion about gestures in learning environments, and no fixed answer choices are offered. There are five main groups of questions:

1. Participant experience in the class
   Example: *What do you think about the setting of the class?*
   The purpose of this group of questions is to understand how the participant feels within the teleconferencing class, the participant's opinion of the current communication technologies used in the class, and the participant's needs in this type of teleconferencing class.
2. Participant interaction in the class
   Example: *What medium/mechanisms do you use to participate in class?*
   The purpose of this group of questions is to understand the difficulty level, amount and type of communication interaction, and the mechanisms used by the participant to participate, in the class.
3. Awareness of participant of classmate participation in the class
   Example: *What do you notice about your classmates' participation in the class?*
   The purpose of this group of questions is to assess the participant's awareness of the difficulty level, amount and type of communication interaction and to understand the awareness of participation and mechanisms used by the participant's classmates.
4. Participant gestures
   Example: *Can you perform the kind of gestures that you perform during the following situations? … Demonstrate agreement/positive feedback.*
   The purpose of this group of questions is to understand the conscious relationship of gesture to meaning by having the participant perform a gesture to represent eight different actions:
   i. Ask for participation
   ii. Avoid participation
   iii. Positive feedback

iv. Negative feedback
v. Certainty
vi. Uncertainty
vii. Active participation
viii. Inactive participation

5. Participant opinion of the relevance of the project
   Example: *Do you think that gestures are an important source of communication?*
   The purpose of this group of questions is to understand the participant's opinion of the research project.

A subset of the questions is asked in a dynamic order, based on how the conversation unfolds between the participant and the researcher.

Finally, the closure section is intended to finalize the interview. The participant is asked about his/her willingness to participate in a follow-up interview, if one is needed to obtain further information.

The length of an interview is no more than one hour. There is no compensation given for involvement in the interview. Furthermore, participation in this study is voluntary and a participant may decline to answer a question at any point during an interview.

Participant Recruitment

There are as many interviews as the number of participants that volunteer. Participants are recruited by giving a letter to each student in the class requesting his/her participation. This letter can be sent via email or given by hand to the student. In this letter, the purpose of conducting an interview is explained, as well as the purpose of the project, the type of questions, the length of the interview, the confidentiality of answers and other technical details.

Recordings in the Interview

Two types of recordings are used, during the interview: a digital video recording and a digital voice recording. The digital voice recording is used as a backup to the digital video recording. If the digital video recording fails, the digital voice recording will be analyzed. NCSU provides the digital video recording equipment, whereas the digital voice recording equipment is obtained by the researcher. The purpose of recording the interviews is to have a better understating of the use of gestures (used for later analysis).

Handling Collected Data

Both observational data and data collected in interviews serve only research purposes. As stated earlier in the IRB submission (see Appendix A), confidentially of the participants is managed by using nicknames and avoiding direct reference to any detailed information that may reveal the identity of a participant. All materials, such as recordings, are destroyed upon completion of the dissertation research.

Data Collection Analysis

Observational Data

The observational data is analyzed with Observer Video Pro (OVP). OVP is a professional system for the collection, analysis, presentation and management of observational data, designed for data entry by a human observer, either *live* or from video, using a desktop or handheld computer (Noldus, 2003). In other words, it is software that translates digital video recorded observations into computer language (coding), and then processes this coding to produce statistics and graphs, based on the data. It is a very new software instrument for the behavioral sciences. OVP can be used to study observable behavior, such as activities, postures, gestures, facial expressions, movements, and social or human-system interactions (Noldus, 2003). It facilitates the process of coding observational data and visualizing the results. OVP requires three steps to analyze data:

1. Configuration
   Independent and dependent variables are setup in OVP.
2. Observation
   Observational data is coded, based on the configuration.
3. Analysis
   Elementary statistics in time-based analysis can be run, based on the coded observations. Reports and tables can be generated, useful for Appendices.

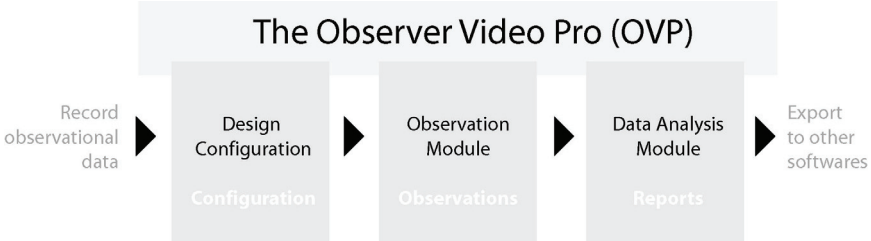

Figure 5: Observer Video Pro

The purpose of using OVP is to systematically identify gesture patterns in interactions and determine which gestures promote participatory outcomes in order to have a participatory gestures vocabulary for use during the experimental study.

OVP is used in a continuous manner. That is, observational data does not have intervals for coding. All behavior is coded through time as it occurs. However, only a portion of the observations is continuously recorded. The researcher selects the most interactive thirty (30) minutes of the teleconferencing class. Therefore, the observational sample covers three classes of thirty (35) minutes each.

Observer Pro Video Configuration

OVP is set up for this study, based on the expansion of a framework for studying gestures from Golden-Meadow (2003a). The proposed framework for studying gestures in distance learning can be summarized with the following four levels:

1. Gesture User
   The purpose of analyzing gestures, at this level, is to identify the delivery channels of verbal and nonverbal information and describe, **who** is producing the gesture, and the direction (**to whom**) in which the gesture is aimed.
2. Gesture Context
   The purpose of analyzing gestures, at this level, is to understand the environment/space, the classroom setting and **where** the gesture is produced/used. Also, it aims to identify any intervention that may produce a gesture, such as professor input, media employed, etc.
3. Gesture Action
   The purpose of analyzing gestures, at this level, is to identify the type of gestures used in the classroom environment. It describes **when** and **how** a gesture is used through time. Also, the stream of motor behavior of a gesture is identified by understanding the form (the shape of the hand as it moves, the trajectory of motion, the location of the hand relative to the body and the orientation of the hand in relation to the motion and the body, posture (e.g. leaning back), and emotional signals (e.g. confidence in the interaction).
4. Gesture Function
   The purpose of analyzing gestures, at this level, is to describe the meaning, the **what** that is trying to be communicated. It aims to identify the compound rules of behavior in learning settings of gestures and to understand the meaning of the gestures.

Interview Data

As compared with the extensive methods available for analyzing quantitative data, the methods for qualitatively analyzing data are rudimentary due to the emphasis on situational and contextual nature (Strauss, 1985). Analysis of qualitative data is synonymous with interpretation of data, which occurs at various levels of explicitness, abstraction and systematization (Strauss, 1985). In this research study, interview data is examined, interpreted and classified into meaningful and mostly salient groups, based on the interview questionnaire and according to the number of interviewees across learning

environments. The purpose is to reduce and integrate data into dimensions and distinctions for the understanding of SIGs. A detailed dimensional approach is described, earlier, under the "face-to-face interviews" section.

For the analysis/interpretation of data, the following criteria are used by the researcher, as introduced by (Strauss, 1985):

1. Avoid simplistic interpretations and perform microscopic examination of complex and evolving interpretations.
2. Experiential data is essential for theoretical sensitivity.
3. The actions of induction (identification), deduction (reduction) and verification will lead to discovery of phenomena.
4. Raise generative questions to stimulate the line of investigation for profitable directions/hypotheses.

Trustworthiness of Naturalistic Inquiries

The criteria of assessing trustworthiness of naturalistic inquiries is addressed with four major concerns (Guba, 1981):

1. Credibility: truth-value
2. Transferability: applicability
3. Dependability: consistency
4. Confirmability: neutrality

Credibility

Credibility is built by demonstrating multiple truth-values concerned with the interpretation of findings. That is, evidence should arise from multiple realities and perceptions towards the findings. In this research study, credibility is confirmed with the use of multiple qualitative data-collection methods. Both observations and interviews are used to *triangulate* the interpretation of data. Coded observational data are analyzed with technical software from the researcher's perspective, and interview answers are used for identifying and confirming the observational data from the participant perspective.

Transferability

Unlike generalizability in rationalistic inquiries, transferability is built by demonstrating enduring findings over times, which are context-dependent truth statements.

> *"Phenomena are intimately tied to the times and the contexts in which they are found"*
> *(Guba, 1981 p.80)*

The idea is that a phenomenon is found in context via unique experiences and cannot be generalized, but rather is transferable in the given context. This research studies the context of education and a purposeful sampling is employed. In order to maximize the transferability, three consecutive observations are employed. This method is intended to maximize the range of information by the number of observations.

Dependability

Dependability is concerned with how stable the credible data is. When dealing with dependability, the researcher should employ overlapping methods to overcome invalidities. It is also recommended to have external auditors or to employ stepwise replication, in which two separate research teams deal separately with the data. Due to the nature of this project (a dissertation study), no further methods of dependability are employed. The researcher is the only investigator throughout the development of the research study.

An overlapping of the methods of observation and interviews is used by this research study in order to validate the findings. Therefore, the weakness of one method (e.g. observations) can be compensated for by the strength of the other method (i.e. interviews).

Confirmability

Confirmability refers to the concept of investigator objectivity towards the data. In other words, it refers to how credible the interpretative measures are from the perspective of the researcher.

In order to support the confirmability of the data, OVP software is used by this research study as the main tool for analyzing data. The configuration of OVP, not only adds consistency to the task of analyzing data, but it also reduces the subjectivity of the researcher in coding the observations. Coding is executed incrementally to continuously verify the previous coding with the current.

For the interview data, software, such as Microsoft Excel, is used to group and code the responses of the interviewees. This software is expected to add consistency and objectivity to the analysis of the responses.

Chapter Conclusions

This chapter describes the use of qualitative methodologies and methods by this research study. The study aims to conduct ethnographic explorative research with the use of observations—fieldwork and interview methods to collect data in a teleconferencing course at NCSU. Both of these qualitative methods are used in this research to add validity and reliability to the findings. The purpose of utilizing the aforementioned research methodologies and methods is to understand the role of gestures in the naturally occurring context, in order to then develop a vocabulary of gestures for the educational arena.

Chapter 7

Phase Two: Experiments in Online Environments - A Quantitative Approach

Overview

The researcher is interested in testing the role of nonverbal information for participation in online learning environments. This research study employs quantitative methodologies and experimental methods. The purpose of conducting the experimental research study is to measure the visual information delivery channels within SIGs that create an affordance of participation in online learning environments. The researcher seeks to discover and measure the impact of visual information, both the nonverbal—Spontaneous Interactive Gestures (SIGs) performance and the graphical representation of meaning—Visual Co-Activations (VCAs) performance affecting the assessment of participation, during online interactions.

Definition of Terms

In this study, participation is defined as the manner in which a student becomes involved in conversation, during the course of a class, such as talking, answering questions, giving positive feedback, avoiding interaction or showing interest. Therefore, participation is measured by the content and number of SIGs those participants in the study are able to distinguish among a group's interaction.

The term visual information channels refers to the nonverbal information communicated by students, both the gestural (SIGs) and the graphical (VCAs) representation of its meaning. SIGs performance refers to the spontaneous hand gestures produced by a student, as used during communication, such as rolling their hands while talking, raising their hands to ask permission to speak or to show positive feedback, crossing their hands to avoid attention, or placing their hand-in-chin to show thoughtfulness or uncertainty. VCAs performance refers to the visual representation of the meaning of SIGs. VCAs visually address the *message* and the *meaning* that a gesture reveals through

the use of visual attributes such as color, size and shape. For example, showing a red frame around a student, who is rolling his hands while talking, calls attention to the fact that he is actually involved in conversation. Affordance refers to "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (Norman, 1990 p.9). Affordances describe and provide clues as to how and why things operate in certain ways. As such, the affordance of participation refers to the assessment and perception of participation measures in the experiment, based on the use of visual information channels.

Proposed Research Design Paradigm for the Study

This research study phase concerns numeric, quantitative data, rather than descriptive data. As such, a quantitative methodological approach is suitable for this study. There are numerous types of quantitative methodological designs, such as correlational, quasi-experimental, simulation research, etc. The selection of a methodology and methods is subject to the nature and theoretical perspective of the research question (Crotty, 1998; Durling & Friedman, 2000). The methodological design is intended to answer the following questions:

- What are the visual channels that best represent and facilitate participation and feedback within online learning environments?
- Do visual co-activations of gestures augment and promote better means for understanding the message being conveyed?

To extend the concept stated earlier, this research study phase aims to measure the visual information delivery channels within SIGs that create an affordance of participation in online learning environments with the goal of discovering relationships between the nature of information delivery and the assessment of participation. More specifically, the first question above addresses the impact of visual channels on student perception of participation. The second question addresses the impact of visual complexity on student perception of nonverbal information: the content and number of SIGs and visualizations within online streaming media.

An experimental research methodology is suitable for this study, for two main reasons:

1. First, there is a belief that reality can be measured and it exists apart from the researcher; and because of the measurable control over the variables and elimination of bias, results will become valid and reliable (Creswell, 1994).
2. Second, the main concern is testing "the effects of actions by observing differences between a situation in which an action is taken and another in which it is not taken" (Polya, 1984 p.65). The researcher is interested in understanding the relationship between cause and effect. The goal is to have comparisons (effects) among groups based on the application of different treatments or conditions (causes).

Experiment

Experimental Variables

The *effects* comprise the dependent variable, and the *causes* the independent variables. In this study, the dependent variable is defined as the amount of participation in online environments, inherent in the actions of nonverbal information, which participants are able to recognize from a simulated online class. A participant is required to assess/distinguish group interactions, based on the independent variables. Therefore, participation is measured by the content and numbers of SIGs that participants are able to distinguish in online group interaction, based on the independent variables. The independent variables are defined as the visual channels of nonverbal information; that is, both gestures (SIGs) and graphic interfaces (VCAs). The purpose of this study is to manipulate the independent variables within different online teleconferencing settings, aiming to cause a measurable recognition outcome in the student's perceived participation. As such, the researcher is interested in measuring the impact (cause and effect) and the extent to which both channels of information have meaningful roles in facilitating and managing participation within online learning environments.

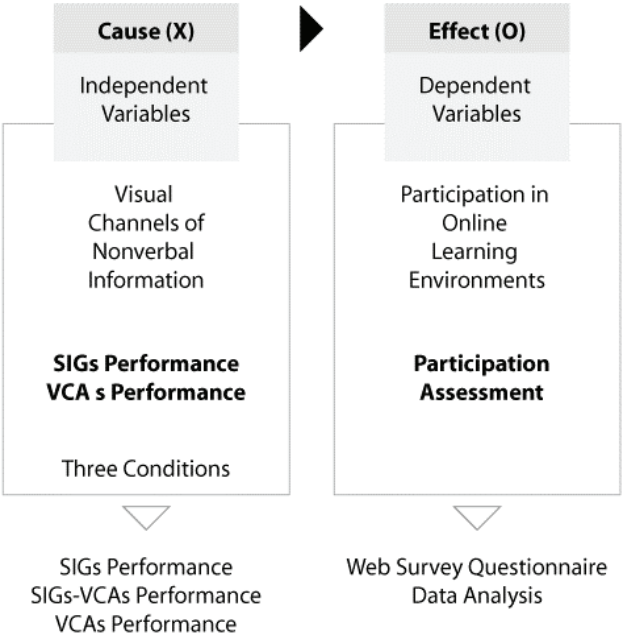

Figure 6: Experimental Variables

Experimental Design

The experimental study employs a static design in which categories and variables are isolated before the study, with the purpose of making generalizations leading to the predictions of the hypothesis (Creswell, 1994). In this study, a 3x1 pure experimental and between-subject design type is followed, in which different individuals are randomly assigned to the different conditions (Creswell, 1994). This procedure involves the random assignment of participants (R) to groups to receive the treatment (X). The design involves an exposure of participants of a group to a treatment followed by a measure: observations (O). The "3" in 3x1 refers to the number of experimental conditions or treatments—independent variables, which in this study are the delivery channels. The "1" refers to the measurable effects—dependent variable, which is the participation assessment. Observations are performed in all experimental groups.

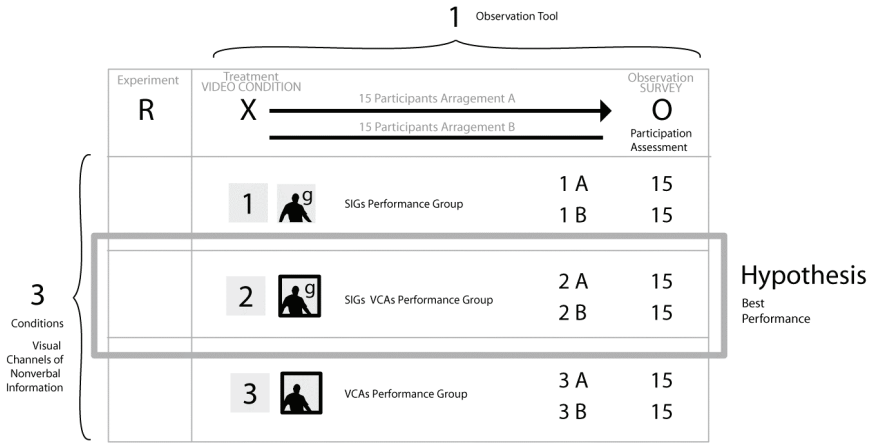

Figure 7: Experimental Design

Experimental Conditions

The experiment is a 3x1 design. Each condition is measured and compared with the others. As such, a total of three experimental groups are measured for each condition:

- Condition 1—SIGs Performance Group
- Condition 2—VCAs-SIGs Performance Group
- Condition 3—VCAs Performance Group

Hypothesis

By studying different types of online teleconferencing settings to measure perceived participation, the researcher seeks to show that a combination of certain hand gestures, along with computer-aided graphic stimuli, affects an online viewer's opinion of the participation of a certain individual.

The hypothesis states that joining both channels of nonverbal information, VCAs-SIGs performance (Condition 2), better facilitates participation during online Computer-Mediated Communications (CMC). Furthermore, it is expected in this study that the VCAs-SIGs has the greatest (positive) effect on the participation assessment of students in the online learning environments.

The researcher hopes to show that a combination of certain hand gestures, along with visual interfaces, affects an online viewer's opinion of the type of participation of a specific individual. In contrast, both the SIGs and VCAs groups, each of which only uses one nonverbal information channel, are less efficient in distinguishing participation than the combined group.

Settings

North Carolina State University (NCSU) is the primary setting for the experimental study. Subjects/participants are recruited primarily from the NCSU campus, since the researcher has access to a large number of people capable of participating in the research study at this location. However, subjects not enrolled at the University were also eligible to participate in the experimental study.

The experiment involves the use of personal computers, which are provided by NCSU in a lab facility. This facility, the Digital Media Lab, located in the DH Hill Library at NCSU, offers the possibility of using a wide range of hardware technologies, as needed, to conduct the experiments: such as personal computers, microphones and headphones. Also, the lab offers an appropriate environment in which to conduct the experiments, since it has: controlled temperature and lighting in which subjects can feel comfortable at all times; a personal seating arrangement that allows more than one experiment to be conducted at the same time without affecting the performance of the experiment; and a quiet soundless setting. Therefore, the Digital Media Lab is the perfect setting for avoiding any distraction during the experiments. Lastly, the central location of the Lab on the second floor/east wing of the D.H. Hill Library in the Learning and Research Center for the Digital Age (http://www.lib.ncsu.edu/administration/lrcda/) is a convenient place to gather subjects for participation in the experimental study.

In some cases, the researcher sent a web-link (URL) to an online copy of the web questionnaire via e-mail to subjects. In these cases, subjects used their own personal computers to complete the experiment. Unfortunately, the environmental settings in these cases cannot be controlled. Therefore, having

subjects participate from their own computers is avoided, unless absolutely necessary.

Sample and Method of Selection

The method of participant selection is a volunteer sampling from both students enrolled at NCSU, as well as professional and personal acquaintances of the researcher.

A total of 90 participants comprised the sample, in which a minimum of 25 participants observed the simulation under each condition. This minimum was chosen, so that a statistical significance is achieved, when analyzing the data.

Subjects, who were located in the general vicinity during the time, when the study was to be performed, were randomly selected as potential participants in the study, and were asked about their willingness to participate. In other cases, the researcher arranged with the professor of a course to offer extra credit for participation in the study. When needed, the researcher sent e-mails to different groups of students and professionals requesting their participation in the experiment. In all cases, the researcher did not pressure a potential subject to participate in any way. No subjects were compensated materially or financially for their participation.

Sample Requirements

Age, gender, nationality and academic affiliation are not conditions for the selection of participants, since these variables do not play a significant role in the outcomes to be measured in the experimental research study. However, the researcher proposes further investigation on the relationship of cultural aspects to the VCAs-SIGs performance. Participant's level of experience with computers is also not a determining factor, since the study requires only the basic tasks of observing online interactions. However, the participant should have a minimum of computer use experience, such as the ability to make use of the mouse to click a response button. In this regard, a filter question was

used in the web survey questionnaire to assure that each participant is qualified to partake in the research study.

The experimental research study was approved by the Institutional Review Board (IRB), as stated in the previous chapter (See Chapter 6: Confidentiality). Subjects are required to accept the terms of a Consent Form (see Appendix A).

In case the participant does not feel confident in using computers for the study, or does not accept the terms of consent, he/she may withdraw at any time and is not counted in the results; in both cases, a replacement participant was chosen at random.

Confidentiality

Subjects accepting the consent form are assured that their identity will not be exposed to the public. As stated in the consent form, the use of acronyms is the primary method for protecting each subject's confidentiality. Participant names remain confidential in all publications. The researcher embeds a text-based form, explaining the anonymity procedures and participation in the study into the web survey (see consent form embedded in the web survey questionnaire in Appendix B).

During participation in the experiment, participants or subjects are required to answer certain personal questions (e.g. gender). However, at no point during the experiment is a participant's name requested. The purpose of these questions is to have demographic/background information of the representative sample to monitor probability of change occurring across conditions. However, this information is not analyzed as variables, affecting the outcomes of the different experimental conditions. Furthermore, no additional information that might compromise a participant is collected in the web questionnaire.

Researcher's Role

The researcher is an observer throughout the course of the experiment. The researcher is completely detached from the data collected to assure the elimination of bias.

Experimental Procedure

Subjects involved in the study are asked to watch a video recording on a computer screen and then answer a web survey questionnaire, based on the video. A participant performs the experiment while seated, at a single computer station. Prior to broadcasting the demo, the researcher briefly explains the purpose of participation in the study, and the procedures and types of question within it. However, a participant can read this information for themselves, since it is included in the directions of the web survey questionnaire. Below are the steps involved in the experiment:

1. Contact subject to participate in the study
    a. By asking directly at the site
    b. By offering a course credit
    c. By e-mail
2. Explain the purpose and length of participation in the study.
   The experiment takes a minimum of 20 minutes to complete.
3. Ask participant to *sign* the Consent Form.
   Explain confidentiality and that no compensation is given for participation. Participants can proceed in the experiment, only if they accept the Consent Form approved by the IRB.
4. Upon agreement, ask the participant to watch a video recording of 13:45 minutes in length.
5. After watching the video recording, ask participant to complete a web survey questionnaire of six sections with (approximately) 30 questions.
6. Once the survey is completed, the participant is finished with the experiment.

Note: there are no risks involved, since *none of the study procedures produce any stress, anxiety or psychological harm to the participant.*

Data Collection Method

Experimental Tools: Treatment and Observations

The experiment is based on the development of a video recording—demo and a web survey questionnaire. Both the demo and survey are self-designed instruments.

The demo is designed for each one of the experimental conditions, for a total of three recordings (see Experimental Conditions section). The demo content is the same across the conditions. Only the visual delivery channels are different. The survey is designed as the measuring tool, and is equal for each one of the experimental conditions. The purpose of having a single measuring tool is to test the differences, performance comparison of results among the groups.

In other words, the demo functions as the treatment tool (X) and the web survey questionnaire as the observation tool (O). During the experiment, the demo is first presented to the participant, after which they are asked to fill out a web survey questionnaire, which is broken up into several parts, each representing a different measure, for both statistical and qualitative analysis.

Demo Development

Characteristics

The demo is a video recording of a simulation of a Distance Education class, which uses multi-video conferencing[3] as the medium for students to interact with one another. The verbal content of the demo does not change across the

[3] Multi-video conferencing allows remotely located people to meet in a face-to-face communication, using the computer as the medium.

groups. Rather, the manner in which the nonverbal information is presented defines the different conditions or treatments in the experiment.

The demo is recorded with a total of seven actors; six play the role of students and one plays the professor. They perform a synchronous online multi-video conferencing class following rules from a designed script for a length of 13:45 minutes. The voices of the actors, along with an image of each, are broadcast in a window format on the computer screen. Therefore, the participant watches seven people interacting (as a group) on the computer screen, during their participation in the experiment.

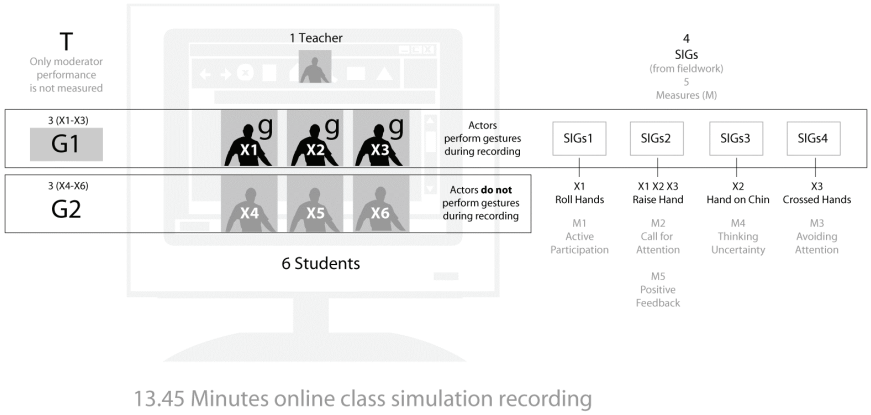

Figure 8: Experimental Demo Design

In the demo, each actor pretends to be in a remote location, in which half of his/her body is displayed in a particular window on the computer screen. Student actors talk and/or use gestures at specific times, according to their designated role in the script. Some student actors use gestures, while talking; while others do nothing, but talk.

The researcher digitally records each actor separately. All recordings are placed and edited together with AfterEffects software to create a single, synchronous interaction piece.

Actor Recruitment and Responsibilities

The actors are not professionals. Due to the funding opportunities in this dissertation research project, actors were recruited among friends of the researcher. The actors were contacted two months in advance to participate in the simulation recording. If the potential actor accepted the opportunity, the researcher met with them to explain their role and desired outcome. In the meeting, the researcher explained that their participation in the demo was strictly voluntary and no compensation was involved. If the actor agreed to participate, he/she was given the script to rehearse. The researcher specified a recording date. On the recoding day, if necessary, footage was repeated, until the desired quality of video was achieved.

Experiment Demo Rules

The development of the demo requires the actors to follow a structured script. The purpose of having a structured script is to have control over the variables of the study correlated to the web survey questionnaire. In order to develop a structured script, there is a need to define *rules* of behavior (acting) for the different student actors, during the recording of the simulation multi-video conferencing class.

There are three main sequential rules:

1. **Equal amount of participation for all actors**[4]
   All student actors participate equally throughout the simulation of the multi-videoconferencing class. That is, all actors talk for about the same length of time. They answer the same number of questions, and in the same order. A detailed set of rules for participation can be summarized as follows:
   a. Four interactions per participant (excluding the instructor)
      i. Two group interactions

[4] "All actors" refers only to the student actors, since the professor's interactions are not measured.

ii. Two individual interactions

b. When a student actor interacts (group and individual) he/she needs to meet each of these criterion only once:
   i. Be the first to answer a question
   ii. Be second to answer a question
   iii. Be third to answer a question

2. **Two groups: G1 and G2**
   The student actors are divided into two groups. One group uses gestures throughout the simulation of the multi-video conferencing class (G1), and the other group does not use any gestures at any point, during the simulation (G2). For example, some actors are asked to perform certain SIGs (e.g. rolling hands) at a specific time throughout the simulation, when participatory interaction and style is requested, based on the demo script. Other actors are asked to avoid performing SIGs and to stay in a neutral position, during the simulation. In summary-
   a. A total of six student actors interact
      i. Three of them do perform SIGs (G1)
      ii. Three of them do not perform SIGs (G2)

3. **Designated measures to G1 actors**
   In this study, there are a total of five participatory (four SIGs) measures (M). Each measure relates to one of the Spontaneous Interactive Gesture variables that have been extracted from conducting fieldwork in Phase One of this study (described in the previous chapter), as follows:
   a. M1: Demonstrate active participation: rolling hands
      The actor randomly moves the hands while talking
   b. M2: Demonstrate calling for attention: raise hand
      Actors orderly raise a hand to answer questions
   c. M3: Demonstrate avoiding attention: cross arms
      The actor crosses arms and leans back during the class
   d. M4: Demonstrate uncertainty: hand on chin/cheek
      The actor places hand on chin or cheek during the class

e. M5: Demonstrate positive feedback: raise hand
Actors orderly raise a hand for counting "yes" answers

Each actor in G1 is in charge of performing a specific SIGs measure during the recording, and one SIGs measure is shared across all G1 actors. Therefore, each G1 actor performs three participatory (two SIGs) measures. For example, an actor may roll hands and raise hands throughout the simulation.

Demo Script Topic and Language

Topics discussed in the demo script are of general interest and of relevance to a wide range of people across disciplines. For example, nutrition was used as a topic for the demo. The idea is to have a topic that is familiar to the observing participants. The researcher is interested in avoiding a situation in which the participant focuses on learning new information during the experiment. Rather, the researcher tests the participant's perception towards the role of gestures, affecting the class dynamics.

The demo script is performed in English, since it is the spoken language of the country, where the dissertation research study is developed. [Actors may speak a different language other than English without affecting the performance of the demo]. Participants are tested by how they understand the visual, rather than the verbal channels.

Professor's Role

The actor performing the role of professor is only in charge of managing the group communication within the simulated class. This role includes introducing topics through the use of questions and statements that generate discussion among the group. However, the professor's performance is not added as a measure in the research experiment. The researcher envisions that future research projects within this experiment will include this dimension, as a measure. Like the other actors, the professor actor was selected from a group of the researcher's peers.

Demo Recording and Editing

Once the demo recording is complete, it is edited. Each actor has been recorded independently. In other words, there are seven separate recordings that are compiled into one unified recording. The researcher uses the Adobe AfterEffects software to perform this compilation, by synchronizing the flow of interactions.

The recorded material is not altered. Rather, the visual display of information is altered, depending on the following conditions/treatments:

- Condition 1—SIGs Performance Group
  No editing is performed, because the condition involves only measuring the use of gestures in group communication.
- Condition 2—VCAs-SIGs Performance Group
  Visual editing is performed, because the condition involves measuring the use of gestures and graphical interfaces in group communication. Therefore, visual displays—visual co-activations are added for the gestures performed.
- Condition 3—VCAs Performance Group
  Visual editing is performed because the condition involves measuring the use of only graphic interfaces in group communication. Therefore, visual displays—visual co-activations are added, and gestures (the video) are removed and replaced with a static image of the actor.

Also, the layout of window locations for each actor is randomly assigned to avoid misleading that might result from participants responding on the basis of actors' locations on the screen. This random placement contributes a validity and reliability to the findings.

There are two arrangements set for each condition. That is, half of the participants watch the demo with the actors in a specific window location arrangement; and the second half watch a different version of the demo with the actors in different window locations.

Visualization of Gestures

Conditions two and three are visually edited, since the purpose of this research project is to test the role of nonverbal information in both gestural and graphical displays. As stated earlier, there are four participatory SIGs measures. Therefore, there are four different graphical representations designed for SIGs:

1. Roll Hands
   The meaning associated with this gesture is active participation. The visual representation of its meaning is a red frame around the window of the actor, who is rolling their hands. It represents the *active* signal of participating in the class. The frame is activated, when there is presence of the use of continuous beat/baton-type gestures, such as rolling hands.
2. Cross Hands
   The meaning of this gesture is associated with avoiding attention, as opposed to being actively involved in the class. The visual representation of its meaning is with 50% transparency (or half opacity) of the entire window of the person performing the gesture. It represents an action of becoming less visible to the audience. The half opacity is activated, when there is a presence of a person crossing arms.
3. Hand on Chin/Cheek
   The meaning of this gesture is associated with uncertainty, generally used by a person interested in getting some understanding on the subject of matter. The visual representation of its meaning is a dotted-red frame around the window of the person performing the gesture. It represents an action of discontinuity of the whole picture. The dotted-red frame is activated, when there is a presence of a person placing their hand on their cheek or chin.
4. Raise Hand
   This gesture is associated with two meanings: calling for attention and delivery of positive feedback, as used by a person interested in getting the attention of the class in order to comment on the subject matter. The visual representation of its meaning is a sequential

number that appears in the window of the person performing the gesture. It represents a total and an ordering of the sequence of students, who raise their hands. For example, the person who raises his/her hand first has the number "1" shown in his/her window. In the same fashion, when delivering positive feedback (e.g. when the professor asks the students a question, such as "How many of you agree with…?") the number of students, who raise their hands to signify "yes" is displayed. A number is activated, when there is a presence of a person raising his/her hand, and this number remains active for ten seconds, before disappearing.

SIGs	Gesture Meaning	Visual Behavior	VCAs
Roll Hands	Active Participation	Red frame around the window	
Raise Hand	Call for Attention Positive Feedback	Sequential number appears in the window	
Cross Arms	Avoid Attention	50% transparency or half opacity	
Hand on Chin	Uncertainty Thinking	Dotted-red frame around the window	

Figure 9: Visualization (VCAs) of Gestures (SIGs)

Note: all graphic interfaces have the same treatment. Red is used as the display color for all conditions, when incorporated. The choice of this color does not hold any meaning in the scope of this research. The purpose of choosing a single color is to avoid variability of responses, based on color, instead of meaning. Also, all graphic interfaces do not incorporate motion or movement.

Participation Measuring Tool

A web survey questionnaire, specifically with a set of fixed questions of both quantitative and qualitative nature related to SIGs encoding, is the primary data collection method (more specifically, the observation-measurement tool).

Web Survey Questionnaire Characteristics

The web survey questionnaire is administered following the treatment (the video recoding). Participants answer the survey questionnaire over the Internet a single time[5,] with unlimited time given to them to answer the questions. However, an average of 25 minutes is necessary to complete the survey experiment, which includes 13:45 minutes of viewing the class simulation video.

Participants are not informed about the kind of conditions under which they are participating in the study. Furthermore, they are not informed about the purpose of the study. They are only informed that they are participating in a study to understand communication structures in the classroom environment. Participant knowledge of the purpose of the study would invalidate the results, since purposeful focus would be placed on gestures. The results of this study are validated by the fact that participants respond based on their assessment of perceived participation without this knowledge.

Instrument Validation

Only one kind of questionnaire is used for all the experimental conditions. That is, the same questionnaire is used for each of Conditions 1, 2 and 3. The purpose of having a single questionnaire across conditions is to validate the research study and develop a parallel comparison of responses.

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[5] If a participant fills out the web survey questionnaire more than one time, it is discarded during data analysis.

Validation of the questionnaire is also achieved by asking the participant questions about a measure from different approaches. Different types of questions are involved in the web survey questionnaire, such as scale, checkmark and open-ended. The participant assesses a measure from observation; justifies his/her assessment from a qualitative basis; and assesses a measure form his/her personal experience. Further explanation is offered in the following sections.

Web Survey Questionnaire Construction

Participants are asked to fill out the questionnaire over the Internet by selecting and typing answers through the use of a computer.

Dreamweaver is a suitable software package allowing the design of questionnaires, since it is an HTML editor for publishing pages on the Internet. Radio buttons, check boxes, pull-down menus and text boxes are incorporated in the design, according to the different type of questions. Also, pictures are used to assist the participants in answering the questions according to their learning styles. For example, the participant can select the answer of a question based on the picture or the name of the student actor.

While completing the web survey questionnaire, participants are given pop-up[6] warnings to avoid incomplete answers. Therefore, a questionnaire is not submitted, until a participant has successfully answered all the questions. The use of these warnings assures that each questionnaire constitutes a qualified response for the study.

Each completed questionnaire remains confidential. There is no information gathered about the participant, or their location (i.e. IP address), without his/her knowledge. Once the questionnaire is complete, the participant clicks

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[6] "Pop-ups" is a name given to messages, usually in a small window, that suddenly appear in the foreground of the Internet page.
(http://whatis.techtarget.com/definition/0,,sid9_gci212806,00.html)

on the "Submit" button, which then sends the results to the researcher's e-mail address.

Even though the questionnaire is the same across conditions, a separate HTML file is created for each condition. Each page has a link to the specific movie condition associated with it. Also, when a participant sends the completed questionnaire, the condition number of the respective page is sent along with other information, such as the time and date. In other words, the differentiated HTML pages benefit the researcher in deciphering the experimental condition group to which the participant belongs. This information is critical to draw on and to analyze the final results.

Questionnaire Instrument

The dependent variable measures the degree to which students encode nonverbal information. The web survey questionnaire includes different sections that construct the measures of the dependent variable (observation), in order to correlate responses among the groups. As such, responses are examined, based on recognition/perception of the nonverbal information inherent in student participation and feedback in the demo under the different conditions. Participants are asked to mark their assessment of a type of participation from specific statements, which are the measures.

Self-designed questionnaires are those that are not borrowed from previous studies. Among the characteristics of a self-designed type of questionnaire is that the researcher can compose a set of questions with the styles that can best inform the study (Creswell, 1994). As such, a web survey questionnaire is designed for specific use in this research study.

The web survey questionnaire is designed with eight sections following the introductory pages. The introductory pages explain the purpose of the project and participation in the study. Participants are asked to *sign* the Consent Form and they are given directions, as to how to proceed to completion of the questionnaire. The purpose of section one is to collect demographic data; section two presents the 13:45 minutes video; and sections three through seven contain the survey questions, based on the

participant perception of the video under different conditions. Finally, section eight serves the purpose of collecting data, based on the participant's perceptions of the relevance of the study.

Section One

Section One is dedicated to obtaining demographic information. Participants are asked about their gender, age, language and affiliation.

Section Two

After participants watch the movie, they are surveyed to measure perceived participation about the six students in the movie. There are five main measures (Section Three through Eight):

1. Participation measure (response - rank 1-6 for 6 students)
2. Call for attention measure (0/1 for 6 students)
3. Avoid attention measure (0/1 for 6 students)
4. Uncertainty measure (0/1 for 6 students)
5. Positive feedback measure (0/1 for 6 students)

Section Three: Active Participation Measure

This section is dedicated to questions regarding the perception of *active participation* from the class simulation video. The style used for measuring and quantifying responses in this section is a scale with a *1-to-6* ranking, which represents the number of actors in the video. Participants are given a diagram of student pseudonyms with the same window orientation as that in the video they viewed. They are asked to rate the group of students from the most to the least active participation. Participant responses offer the researcher insight as to the value of nonverbal information that is processed regarding active participation, since (as stated earlier) all actors are involved to the same extent in the class simulation video.

Following this ranking question, a qualitative set of questions is given. A participant needs to use his/her own words to describe how he/she was able

recognize the students, who participated the most and the least. The qualitative questions support the researcher's understanding of participant responses.

Section Four: Call for Attention Measure

This section is dedicated to posing questions, regarding the perception of *calling for attention* in the class simulation video. The style used for measuring and quantifying responses in this section varies. First, the participant is asked to select an answer from different possibilities, as to which mechanism was used to demonstrate calling for attention. Then the participant is asked, which mechanism they would prefer to use in a video conferencing situation to call for attention.

The participant is asked to select, via a checkbox, from a diagram (similar to the one mentioned in Section Three) as to which student called for attention the most. Participant responses tell the researcher the value of the nonverbal information that is processed, that of calling for attention. Again, all actors call for attention the same number of times in the video.

Following the checkmark question is a qualitative question in which the participant needs to use his/her own words to describe how he/she was able to recognize the students, who called for attention.

Section Five: Avoid Attention Measure

This section is dedicated to asking questions, regarding the perception of *avoiding attention* in the class simulation video. The format of the questions in this section is essentially the same as those in the previous section, except that the questions relate to avoiding, rather than calling for attention. Participant responses tell the researcher the value of the nonverbal information that is processed, that of avoiding attention. This time it is known that only one actor attempts to avoid attention in the video.

Section Six: Uncertainty Measure

This section is dedicated to posing questions, regarding the perception of *uncertainty* in the class simulation video. The format of the questions in this section is essentially the same as those in the previous section, except the questions relate to uncertainty instead of attention. Participant responses tell the researcher the value of the nonverbal information that is processed, that of avoiding attention. Again, it is known that only one actor is showing uncertainty in the video.

Section Seven: Positive Feedback Measure

This section is dedicated to asking questions regarding the perception of *positive feedback* in the class simulation video. The format of the questions in this section is essentially the same as those in the previous section, except the questions relate to positive feedback instead of uncertainty. Participant responses tell the researcher the value of the nonverbal information that is processed, that of positive feedback; again, it is known that only one actor is showing positive feedback in the video.

Section Eight

This section is dedicated to the closure of the web survey questionnaire. Participants are asked questions about the number of gestures perceived, as well as their opinion of the relevance of those gestures.

Survey Administration

In the web survey questionnaire, an introductory page asks participants to sign a Consent Form. If the participant accepts/consents to participate in the experiment, he/she is directed to the survey. If the participant declines to accept/consent, he/she is directed to a “thank you” page with no further involvement in the experimental study.

Data Analysis

Interpretation

Within the web survey questionnaire, there are two sets of results: quantitative and qualitative data. For the qualitative set of results, data is interpreted and coded into meaningful categories. The purpose of coding qualitative data through interpretation of responses is to have a consistent set of data for running descriptive statistics. As such, descriptive statistics are used to explain how the participant assesses participation.

Data Analysis

Statistical analyses are performed for the quantitative set of information—measures (content and number of SIGs) of the experimental design.

Two main statistical analyses of the data are used: descriptive and inferential.

JMP and Microsoft Excel softwares are used to develop descriptive statistics, including the mean, the mode, standard deviations, minimum and maximum range values, and percentages. This analysis is used for each of the sections of the survey questionnaire.

Also, the types of inferential statistics that are used to test the hypothesis in this study are: one-way test for Analysis of Variance (ANOVA), McNemar's test for dependent proportions, and the Chi-Square test of independence.

The statistical analyses are explained in the results and discussion chapter. For easy understanding, analyses are explained by sections from the web survey questionnaire, which includes answering the following questions for each:

> Let G1 be the actors, who gesture (X1, X2, X3); and G2 the actors, who do not gesture (X4, X5, X6).
>
> Let X1 be SIGs Active Participation; X2 SIGs Uncertainty/Thinking; and X3 SIGs Avoid Attention.

1. Is there a difference between G1 and G2 over all conditions?
   Define a variable Y=(X1+X2+X3)/3-(X4+X5+X6)/3.
   If the mean of Y is not 0, then one can say that there is a difference between G1 and G2.

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Figure 10: Group Difference Data Analysis

2. Is there a difference among conditions?
   Because there are three conditions (treatments), a one-way ANOVA (Analysis Of Variance) is used. Also, a difference test between two conditions is performed, if there are differences among three conditions.

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Figure 11: Conditions Difference Data Analysis

3. Is there a difference among the three students of G1 (X1, X2, and X3) over all the conditions?
   For the first section, we apply one-way ANOVA in which three students are used as the treatment under ANOVA. For others, three sets (X1*X2, X2*X3, X1*X3) are considered and "McNemar's Test" for dependent proportions is used on each set, because of a dichotomous (0/1) response. Generally, the researcher uses "McNemar's Test" to calculate the difference between two groups, when the response is 0 or 1.

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Figure 12: Group 1 Difference Data Analysis

4. Is there a difference among the conditions of G1?
   Let Y1=(X1+X2+X3)/3. Again, one-way ANOVA is used.

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Figure 13: Condition Group 1 Difference Data Analysis

5. Focusing on the target response of each section (i.e. focusing on the actor who performs a specific gesture), is there a difference among the conditions in each case?
   This question considers, whether the response at each case is associated with the conditions. The test of independence, that is, Chi-Square test, is considered here.

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Figure 14: Measure Condition Group 1 Difference Data Analysis

Chapter Conclusions

This chapter describes the use of quantitative methodologies and methods in this research study. The study aims to conduct a pure experiment with a 3x1 in-between subject research design with the use of the development of a multi-video conferencing simulation as the treatment for the different conditions and a web survey questionnaire as the measuring tool. The purpose of utilizing the aforementioned research methodologies and methods is to test the relevance of both of the visual channels of nonverbal information: gestures (SIGs) and visual co-activations (VCA). The hypothesis states that by joining both of these channels of nonverbal information, participation is better facilitated during online Computer-Mediated Communications (CMC). Statistical analysis of data includes descriptive statistics and inferential statistics to test the hypothesis, such as one-way ANOVA, McNemar's test for dependent proportions, and the Chi-Square test of independence.

Chapter 8

Limitations, Significance and Consequences

Discussion of the limitations and significance of the investigation are described in this chapter. It also includes justification and aspects that were not implemented or carried out with the proposed methodologies. Consequences are discussed with the impact of the research findings.

Limitations of the Study

About Gestures

There are many types of gestures. Some people use gestures alone, others to support speech. The goal of this study is to understand the underlying meaning of nonverbal information that reveals user intentions. Therefore, the study of gestures in this research refers to those gestures that are not accompanied by speech, such as deictic (i.e. pointing gestures) and in which their meaning can stand alone and does not include either verbal or environmental information to complete the meaning of the message.

There are also different performances of gestures. They can occur spontaneously (usually unconscious and abstract) or more consciously (usually structured, such as sign language). This research study focuses on those gestures that are spontaneous in nature.

Gestures can be performed with different parts of the human body, such as facial gestures, hands, body language, etc. This research study focuses only on hand gestures as the part of the body that is more expressive and regulatory.

A gesture can have multiple meanings. As earlier explained, gestures are context-sensitive (McNeill, 1992) or context-dependent. Raising a hand can represent calling for a cab, trying to call for attention to ask a question, saying "hi" to someone from a distance, etc. The study of gesture in this research is limited to learning environments. Therefore, gestures are analyzed only

within the classroom environment. The proposed gesture vocabulary represents meanings of gestures encountered in that learning environment.

As gestures are context-sensitive, the nature of their production and intention must be considered relative to the environment, where they occur. Since these gestures are studied in learning environments, the limitation in the research is that of focusing on a set of participatory gestures, such as hand raising, with its inherent symbolic meaning of calling for attention.

In summary, the study of gestures in this research study is limited to the following gesture characteristics:

- **Not accompanied by speech**
- **Produced spontaneously**
- **Limited in focus to hand gestures**
- **Developed in learning environments**
- **Linked to participatory measures**

About Funding

This research study is not funded. Therefore, the research methodologies proposed are limited in their scope, execution and duration. The present design has been chosen and constrained by an ethnographic and experimental methodological approach that is both feasible and affordable, and that can be implemented with immediacy.

Currently, multi-video conferencing classes are limited in their implementation. Though the research proposes studying gestures in natural occurring contexts, this study uses teleconferencing courses, instead of multi-video conferencing.

There is also a limitation in the experimental research phase. The experimental research methodology uses volunteer actors for the class simulation video, as opposed to professional actors, since professional actors would expect compensation for their participation in the study. Other characteristics of this research have been also limited by the lack of funding

and are explained under Chapter 10: Recommendations for Future Research of this paper.

Vision for Computers

This research study presumes the use of vision-based interfaces (VBI) in multi-video conferencing for computer-mediated communication (see Chapter 2: Definition of Terms for system explanation). Experiments based on VBI cannot be applied momentarily. First, special equipment is needed. Unfortunately, the institution where the researcher is executing this project does not own this equipment. Second, extensive knowledge is needed to operate the equipment. The researcher does not have either the knowledge to operate the equipment herself or the funding to hire assistants to perform this task. As such, a simulation at a videoconferencing class is substituted. However, the researcher expects to be able to replicate these findings with the actual use of VBI systems.

Researcher

The researcher is the sole developer of this research study, with the guidance and supervision of the Dissertation Advisory Chair and other Committee members. That is to say, the problem statement, literature review, methodology, data analysis, and writing have been developed without a research lab or in conjunction with other researchers.

Most of the research project has been evolved successfully under these conditions, although the data analysis in Phase One would have benefited from having other researchers participation for data coding and analysis in order to add further credibility to the findings. However, for validity and reliability of the findings, the students of the NC State University Statistics Department helped in developing the data analysis of Phase Two.

Significance of the Study

Multidisciplinary Approach

The main significance of this study is its multidisciplinary approach. The project aimed at linking the fields of Computer Science, Social Sciences, Education and Design into a unified research problem:

> The Computer Science field usually lacks of rigorous evaluation in the field of the latest technological advancements applications.
>
> The Social Sciences have endless models to understand the human and his/her relationships with both the natural environment and those human-made.
>
> Today, Distance Education is growing rapidly but lacks innovation in building its student-centered characteristics.
>
> The Design field can function as the catalyst for purposeful progress at the intersection of these fields.

The focus of this research is that of creating knowledge that can best help in building more integrative learning environments in which individuals can interact and communicate via seamless computer communication technologies.

The Human Body and The Use of Technology in Communication

This research is concerned with validating the role of the human body in technology-rich environments and promoting more purposeful and friendly remote synchronous interactions through design. There are three main issues in which the human role is significant in conducting this study:

1. Natural abilities of the human body
2. Humanization of technology
3. Human body as the medium of communication

First, the human body possesses unique communicative abilities, with the hands being natural devices to aid communication. They function as extensions of the mind in the use of symbolic representation and nonverbal language.

Second, nonverbal body language can be a factor in developing more personal and natural communication interactions through the use of currently evolving vision-based interfaces. The significance of such efforts reside not only in having technology adapt to the user, but naturalize the human-to-human communication, when mediated by computers.

Third, it is important to make the role of the human body as a means of communication more meaningful for future computer interaction applications. Current mechanisms separate intentions from actions, in terms of natural and spontaneous interactions with computers. The human being/body can function not only as a vehicle to convey the content of the message (intention), but primarily as the emergent medium of such a message.

In summary, the significance of the study is to make meaningful the role of the human body as an input mechanism for computer applications with respect to the use of natural language interfaces.

Paradigm Shift: Designing Thinking Tools

A major outcome of this study would be to accomplish a paradigm shift in the Information Design community. Unlike traditional practices, the content of design is not just a product presentation, but a user-centered, dynamic contribution to meaning. Using gestures in the field of Information Design is to shift from focusing on the design of information or signs to a focus on designing for thinking/cognitive tools.

This research deals with understanding the role of human abilities in technology-rich environments. The significance of this study is the design intervention in computer-mediated communication and to advance research

towards validating the role of Information Design in Education and the use of visual interfaces that are created by and responsive to the user.

Inclusive Tools

Distance Education programs are continuously growing overcoming the physical and economic and technological limitations. However, Distance Education environments are unsatisfying and insolvent in terms of interaction. As Distance Education becomes mainstream for learning experiences, more attention should be paid to the role of culture. Beyond aspects directly applied in this study, there is a need to advance *smart tools* that can bridge the transition across cultures and recognize the *international* aspect of gestures in Distance Education. Some gestures possess culturally-specific meanings.

The significance of this study is to provide knowledge in visualizing the manner in which people communicate with one another through the use of gestures, as the first steps of studying contextual nonverbal information for future cross-cultural applications.

Focusing on Collaboration

Lastly, by envisioning a nonverbal mode of communication (gestures relevant for Groupware) the researcher hopes to foster a research community interested in increasing the potentials for people to interact and collaborate as a group. Especially, communities interested in developing applications in education that foster interaction between teacher and students in remote sites. Vision-based interfaces, based on the study of gestures, will have a significant role in computer-mediated communication, as a tool that can reduce actions in the communication process into understandable sets of information. Visualizing gestures means promoting effective systems that are inclusive, integrative and, more importantly, responsive to the promotion of computer technologies for remote educational experiences that support social communication processes. This need responds to the fact to make Distance Education more integrative, interactive, real-time, learner-centered, and less ambiguous; to making visible and measurable the means of human

communication through computers. In summary, the significance of this study is to advance research in the use of innovative technologies in supporting best practices in education; to provide better online instructional environments that support more fluid and effective forms of discourse in group interaction for teaching and learning.

Design Research

The ultimate purpose of this project is to use this study to transform scientific knowledge and observational paradigms into an applied discipline. It is to demonstrate how an aspect of teaching and learning can be studied and integrated into a situation that is less than satisfying replication of traditional classrooms. Therefore, this research falls within the main interests of the Information Design program, which includes improving a person's understanding and interpretation of his/her social environment, and also in improving visual communications and development of technology applications in order to meet human needs. Furthermore, it is concerned with managing the relationship between people and information and making such information accessible and usable for the human community (Penman & Sless, 1992).

Consequences of the Study

Advancing the Findings

Different research arenas can benefit from this study. As described earlier, a multidisciplinary approach is advanced in order to see connections on a deeper level and widen implications to the importance of design for education and human-centered issues within computer technologies. Therefore, the findings can significantly impact research on the following knowledge areas: Education; Information Design; Social Sciences; and Computer Sciences.

Consequences for Education

This research project will lead to new discoveries and have substantial impact on progress in the adoption of computer technologies in education. The success of implementation would require a qualitative basis of how SIGs occur in naturally grounded contexts, such as college learning environments. Having more *natural* interfaces with computers will reduce adoption time, since it will be more intuitive and easier for the user to learn.

Also, the findings of this study will contribute specifically to the current literature of providing a gesture vocabulary for education. Literature of gesture in education is limited. The findings of this research would amplify knowledge of gestures studied in the specific context of learning environments. Understanding the role of certain gestures linked to collaborative/participation behavior can benefit professors in understanding and managing interaction in the classroom.

Recent Distance Education strategies lack efficient systems to quantify and qualify amount of participation in the online classroom. There is a need for systems able to assess student participation, during online classes. Thus, the need for tools that can aid the process of measuring online participation is essential. This research can have an impact on research communities interested in developing novel systems that are able to function as assessment tools, not only to study student interaction, but also to aid management of group communication.

Consequences for Information Design

Information Design claims a new way to deal with information within online interactions, moving from a focus on the tools to produce content, to a focus on the content itself (Carliner, 2000). The relevance of this research is to explore the visual, social, cognitive and technological implications for the forthcoming Information Design applications within the understanding of nonverbal information for educational purposes. The design research problem would explore a novel relationship of how people communicate with the use of gestures, shaping these visual interactions. As such, the

findings would significantly contribute to a discipline-shifting paradigm. New research problems can be explored from this study of Information Design for communication and interaction within computer technologies. In conclusion, the importance of the study in design research is to extend research knowledge for new research directions within design interventions.

Consequences for Social Sciences

It is envisioned that this research study will lead to emergent discoveries, which will further demand multi-disciplinary approaches of Design, Social and Computer Sciences with particular emphasis across disciplines interested in contributing to the principles for designing tools that will facilitate, augment and negotiate understanding among people and the collaborative component of gestures for distant communications.

Consequences for Computer Science

The significance of Information Design is to focus more on learning from the face-to-face human communication interaction for the later designing of visual computer interfaces that are bounded in natural social/contextual phenomena. This approach has created an amazing opportunity for designers to visualize the manner in which people communicate with one another, with the purpose of providing contextual information for the computer science community and future application of natural language interfaces in Groupware.

More importantly, the consequences for the computer science knowledge area are to provide for the need of developing systems that support *translations* of human behavior, including the international aspect of gestures; to engender more natural human interactions among several users communicating through computers; and to promote universally effective systems that are inclusive, integrative and more importantly, responsive across users and that will be implemented with vision-based interfaces, natural language systems, and synchronous computer-mediated communication.

Chapter Conclusions

There are a variety of benefits from conducting this dissertation research. They include understanding that the human body possesses distinct communication abilities that augment the visibility of human behavior in shared information spaces within learning group interactions. This nonverbal language can be captured by vision-based interfaces and can make more user-friendly communication devices for computer applications for education. Computers can not only adapt to users and their gesture production, but make the role of the human body more meaningful in computer-aided communication. Studying gestures in education proposes a paradigm shift for the Information Design discipline, by shifting the focus from designing information presentations to designing dynamic tools for categorizing social behavior. These discoveries could have an impact on the adoption of computer technologies by bringing new knowledge of a gestures vocabulary to the repertoire of teaching and learning strategies in Distance Education; and building foundations for the further development of natural language computer interfaces.

Chapter 9

Findings and Discussion

This chapter discusses the research findings. For ease of readability, the discussion is divided into two main categories, which correspond to the methodologies used in the study:

1. Phase One
   Qualitative Research findings
2. Phase Two
   Quantitative Research Findings

Phase One
Qualitative Research Findings
Communication Beyond Words in the Classroom

Phase One of the research project aimed to identify a vocabulary of interactive gestures utilized in learning environments, and to then extract the gestures variables to be used under the experimental conditions. Observations and interviews were conducted with the purpose of answering the first research questions of the study:

- What are the potential gestures used in participation within learning environments? To what extent can these gestures be translated into computer interfaces for online distance learning?

What research says about distance learning environments

Observations and Interview Methods

A total of three consecutive observations were recorded in February 2004 in a course that offers distance education and uses teleconferencing at North Carolina State University (NCSU). The purpose of the course was to teach special topics in Horticultural Science. Different professors from different locations (either academic or industry) delivered lectures related to crop

management. For confidentiality purposes, I will not give the name of the course. The observations lasted three hours each. All observations were video-recorded. Some students from the observed course were interviewed. Interviews were voluntary. The purpose of the interviews was to validate the observational findings. Each interview took an average of 45 minutes. Interviews were video-recorded for the purpose of capturing the participants' gestures and were also digitally tape recorded for transcriptions.

Studies of a Teleconferencing Course

The class met once a week for a period of less than three hours. There was only one break in the three-hour class, usually around the middle of the class. Many students were involved in the class from different sites. However, I conducted observations in only seven of the local and remote sites. Other students were discarded for analysis due to the limited visibility of their participation in the class. During all observations, I focused only on the class dynamics. As such, I was only an observer. I did not participate or interfere with any of the professor-student interactions. The reason for being an observer was to preserve the *naturally occurring phenomena* in the class interactions.

Pilot Observation

Prior to entering the field and recording the three observations, I performed a pilot study; I was an observer for an entire lecture to ensure the efficiency of my recording materials (both equipment and observational tools) prior to officially recording the observations. The pilot study allowed me to refine the materials to be used. To my surprise, an observational tool I designed (see Appendix B) turned out to be inefficient for gathering the observations within such a complex environment. The tool covered a wide range of items to analyze the gesture performance. Since this research was based on conducting continuous observations and intervals were not present for the observations, there was not enough time to make use of all items included in the tool. I decided to proceed only by taking notes as behavior occurred.

I also discovered the best location in the classroom to conduct my observations. I was seated in a corner of the classroom next to my camera, which was recording the class interactions. This location gave me a good perspective for viewing all students in both local and remote locations. Being next to my camera allowed me to zoom in and out on the participants. Even though I was seated at the front of the room, it was a corner space that is less visible to the students. From this vantage point, I did not disturb the students, as I wrote my notes.

Video Recordings

Since I conducted observations with video recordings, I always arrived to the class 10 minutes prior to the lecture to prepare the equipment. I recorded the interactions for the entire length of the class (an average of 2.15 hours per observation) with only one video camera in my possession. However, I was given a videotape copy of each class I observed (total of three). The technicians recorded those copies during the broadcasting of the class for the purpose of documenting teaching materials for distance educational purposes. Having their copies allowed me to confirm and integrate my observations. There were several times during which I could not record two students simultaneously and this helped me to recover data. I synchronized both video recordings for the complete recovery of the real-life situation.

The Classroom Sites

The NCSU course, I observed, served the University's Distance Education program. A total of four different sites were involved in this course: a local site at NCSU, and remote sites in Fletcher, UNC Pembroke and Kingston. All sites were located in North Carolina; however, the settings for each of the sites involved in this course were quite different.

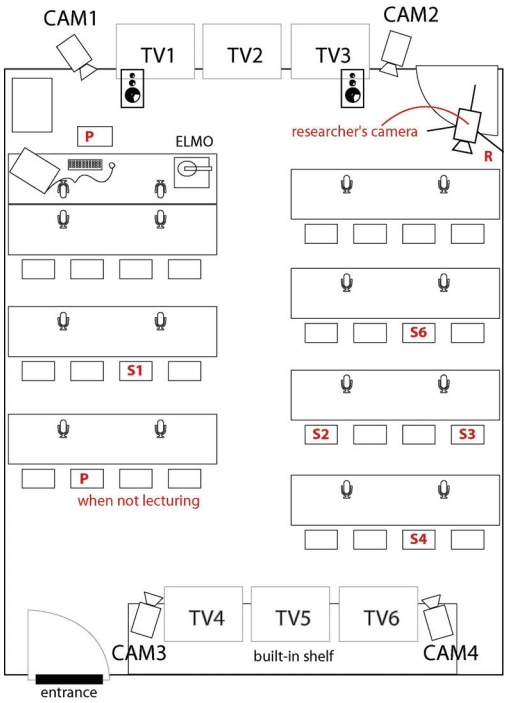


Figure 15: Local Site Settings

First, the site at NCSU was a regular classroom setting equipped with media technologies. That is, there were seven rectangular tables in the room that could seat four students each. Each table had two microphones, each shared by two students. Students are seated in a row format, not in a circle. They were set in the room facing the professor. The professor's table was at the front of the room facing the students. On the table, a computer with a monitor, keyboard and mouse, as well as an ELMO projector, was available for the professor to use. The drawing above represents the room arrangement.

The lighting was artificial but good, clear and luminous. The temperature in the room was ideal, in the sense that it was neither cold nor hot, and it remained constant throughout all observations. Everything was perfectly controlled. However, what attracted the most attention were the six TVs located in the room. Three TVs in the back were used by the instructor to see (for example) what is being presented; and three TVs were located at the front

for students' use. Therefore, the students were looking at TVs for the entire class instead of the traditional chalkboard.

Next to the TVs were four cameras that recorded the class, two at the front and the other two in the back. They seemed to be purposefully designed to be less noticeable, as they are embedded in the wall. There were also two speakers hanging on the front wall. There was nothing on the side walls of the room. The entire room seemed to be a mirror of how the equipment was located, which replicated the teaching model of having the professor and students facing each other.

The cameras were used, not only to record the class for later use as teaching material, but also to send the class experience in real-time to other sites or classroom environments. Students located at other sites could become part of the same class. What is interesting in these communication systems is that, unlike the teaching model that is experienced in the local classroom, the system disappears for learners at a distance. That is, both students and professors encounter the same level of information or arrangement. The remote students and the professor experience in the same visual field as the rest of the students attending the lecture class. To an extent, professor's and students' roles are reduced to the same status, sharing a meaningful position and role in the learning environment.

Local Classroom Information System

There are a total of 6 TVs in the teleconferencing-learning environment. As explained earlier, three TVs are located at the front of the room, where the professor's desk is located, and the other three are located in the back of the room. The purpose of this arrangement is to give the professor access to the three TVs in the back while teaching, and the students sitting in the lecture class can receive the same information through the front TVs. I will refer to the TVP1, TVP2, TVP3 for the TVs located on the back of the room from left to right where the professor has access to; and TVS1, TVS2, TVS3 for the TVs located on the front of the room from left to right to where the students have access.

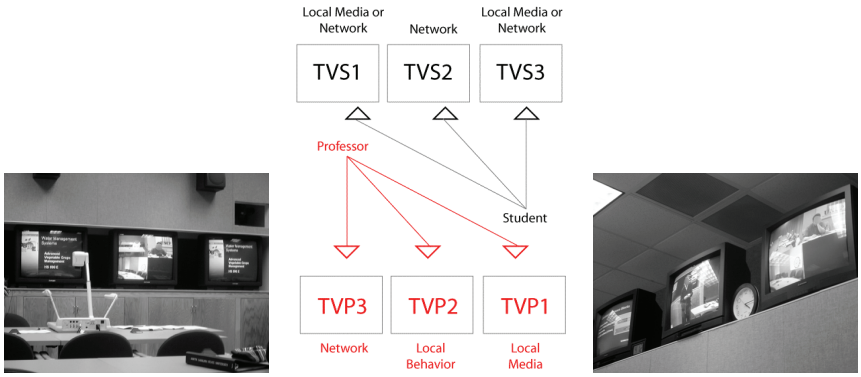


Figure 16: Local Site Television Arrangements

Each of the TVs display different information, however some of them are synchronized to display the same information. The technicians, who are located in a separate back room, control the information display. Usually, TVP1 (see above diagram to understand acronyms) displays media that is being used by a local lecturer to support the teaching experience, such as a slide presentation. The slide presentation is also usually displayed on TVS1 and TVS3. Besides slide presentations, it can also display projections, videos, etc. If media is not being used, TVP1 would remain black, while TVS1 and TVS3 would display network information.

Network is basically the information received form the remote locations. Usually, TVP3 displays such as information, as well as all front TVs (TVS1, TVS2, TVS3). Usually, displays a split screen of the different locations involved in the class. It also displays whatever media is used by any of the remote locations, such as slide. Only 4 splits are allowed on the TV screen. The upper left quadrant displays the same information as TVP2 .The following quadrants is are left for the remote locations. My observations included the classroom from the University of Pembroke (in the upper right quadrant) and Fletcher and Kingston (both in the bottom left quadrant). Unfortunately, the bottom right quadrant was blacked out for all my observations. Each quadrant displayed the output from cameras connected to specific technologies. NCSU and the University of Pembroke both had their own technologies. Fletcher and Kingston were sharing technologies to access the teleconferencing course. Therefore, only one display/quadrant was used for both, where

Fletcher was the primary image received. As such, I removed the student in Kingston to conduct my observations, since I was not given the opportunity to record the site. All information coming from the network is not controlled by any of the technicians from the sites. Rather, it is controlled by the network provider or media center manager, which in this case is MCNC.

TVP2 is mainly used to display current local behavior of the local classroom that would be used to send to the network. In this case, it displays professors, students and media that occur in the NCSU classroom. In other words, if the professor is lecturing, a close-up of the professor is displayed. If the professor is lecturing about a media material (either slides, videos, documents, etc), the media material is displayed. If the student raises a question, the camera is directed to the student and therefore, these TVs display an overview or close-up of the student asking the question. Note, what is being displayed in these TVs, is the information the remote locations receive from the local classroom at NCSU. If only the professor is displayed for the entire class, the remotely located students only see the professor for the length of the class.

From my observations, two important problems result from the current system. First, all locations are able to send and receive, simultaneously, information and behavior that is occurring in the site. However, there is a small time delay (less than a second). In other words, for example, the remote locations receive the NCSU output behavior less than a second later after its occurrence. Second, when the class is taught by a remote professor, the split display in the right TVs is switched to a close-up view of the professor. This means that, unfortunately, none of the students, either local or remote, had access to each other's visual. Moreover, if the split screen is replaced by a media presentation, then at certain times students in the local classroom watched the media presentation on all of the front student TVs.

Remote Sites: Fletcher, Kingston and Pembroke

The remote sites had the same equipment to establish the communication interaction (i.e. the use of TVs, video cameras, speakers and microphones). They might have varied in the amount and quality of the equipment used. Aside from these equipment similarities, the arrangement of the classrooms

was significantly diverse. The Fletcher setting was a meeting room, where a single round table accommodates students. Kinston and Pembroke sites were small classrooms. They function solely for teleconferencing environments, since the professor's desk was visually absent from the sites.

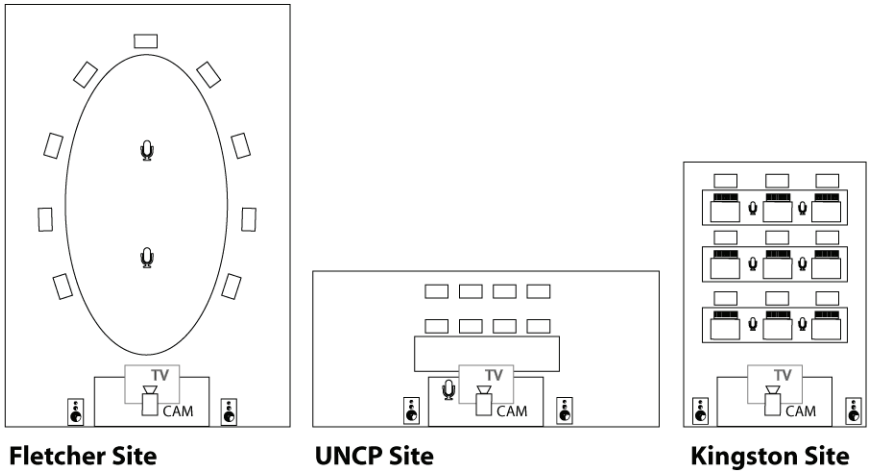


Figure 17: Remote Sites Settings

The three sites used standard equipment; a single camera recorded all the people in the room. This created a problem for watching people in general, not just their gestures. For example, Fletcher had one camera to film three people in the room; it was difficult to determine who was talking. One could easily differentiate the only female in the room. However, it was hard to distinguish which male was talking. The Kingston site had the same problem, but with a single student enrolled. Finally, the Pembroke site also had a single camera, however, the classroom size was small and the student was seated in the front row. This made a close-up of the student possible. In general, cameras from the site were able to deliver the visual of the student's full upper body. The difference relied on how visible the students were with the use of those camera settings.

The Subjects

As stated earlier, confidentiality of subjects was preserved. Therefore, before conducting observations or fieldwork, the IRB (Institutional Review Board)

approved the research study (see Chapter 6: Entry to the Research Field). Moreover, each participant's name was discarded in this study. I used acronyms for the entire study, such as S1, S2…R1, and R2. "S" stands for a student located in the local site, and "R" stands for a student located in the remote site. The numbers indicate which student I was observing. I assigned all the acronyms in my pilot study by the position of the student in the class. Unfortunately, in my subsequent observations, one of the students from the local site dropped the class (S5), and I discarded her from the observations. Another student (R3) was discarded due to only a single appearance throughout my observations. As such, my observations were conducted with seven out of the ten students that were involved in the class:

- Five local students:
  S1; S2; S3; S4; S6
- Two remote students:
  R1; R2

Students in the local classroom were seated far apart from each other. Some students seemed to be friends, since as graduate students they were sharing other classes together. Those students sat closer together than the rest of the class. None of the students changed their seating location through the rest of my observations (see Page 103).

Among the remote students, one sat in the same location in each class meeting. Another remote student changed location from observation to observation.

The Context of Non-Verbal Information

The class experience

The class started, when the professor asked an unusually loud question, such as "Fletcher, are you there?" Three seconds later, Fletcher answered "yes, we are here". To my surprise, I realized that "Fletcher" is the name of a location in the mountains of North Carolina, not a student. More gaps of silence followed each interaction. Then, the professor asked "is everyone here?" He continued to ask the remotely located students to confirm their presence in the class.

Within the three-second timeframe, students who were located remotely started speaking. The speakers in the classroom switched from loud to soft. Local students seemed confused about the source of audio. Then, the professor made an interesting statement:

"Talk a little bit more, so we can see you"

I realized that the technicians, who were located in a private next-door room, needed this kind of signal or marker to place the image of the speaker on the big screen; otherwise the students never got the chance to be seen on screen. I recall the professor asking the technician to have more "visualization" of the remote students during the class. As such, the interaction is moderated and mediated by the technician. Thus, the technicians function as interpreters in the communication process.

"When somebody's hot, because they come on full screen"

Figure 18: Teleconferencing Equipment

> *"Yeah. We have many classes… right now…we have three classes that are held in there (thinking)…so...I mean and it changes semester to semester and also during the summer…plus we have other video conferences like for example today this morning we had a global seminar…." (Television Engineer)*

The technician plays a crucial and difficult role in facilitating the communication interaction in the class. Partially, the technician performs one role of "teacher" of the class, since he determines what audio and video is available to the audience. As such, I encouraged myself to learn more about the technician's activities. Not only did I hold an interview with the director of technicians, but I also was given the opportunity to moderate the class from the booth. I discovered that not only must one multitask with different equipment, but also pay attention to multiple activities and small behavior nuances produced by the students during the class. A small gesture, such as changing posture or slightly raising one hand, necessitated having equipment ready to display the students wanting to speak. Sometimes, there were no visuals from the remote locations. Many times the system broadcasted sounds of doors being opened and closed, making a disruption of instruction and student response.

> *"There is a lot of lag in between…our side and the other side…I think it is harder to …if someone/they don't get your meaning right away, it takes so much time to ask questions …and want to call up a lot. I do but I feel bad about having to re-ask the question because it takes so much time…and that sort…ah…it just feels like interrupting a lecture…It is…(thinking) inconvenient…I don't know…I…just find it awkward"*

The overall experience was disruptive due to problems with the rapid feedback mechanism that allowed interaction between environments. During interaction in distance learning environments it is harder to get meaning across right away. Many times there is a lag in sound, images unlinked with sound, and the student simply ends up talking to strangers in one small learning community.

When introducing myself to the class, I talked first with the local students. Soon enough, I remembered that I should have been addressing the remote students as well. It was awkward to talk to both environments at the same time, especially when addressing TVs instead of people. In other cases, to participants that were not visible at all.

In the same fashion, the local students interacting in the class managed to establish eye contact and gestured while talking, mostly ignoring the remote students. Surprisingly, when talking to the remote students, they addressed the front TVs. Even though they could not see the students or establish eye contact, they were gesturing, while talking to a TV. Sometimes, gestures were not used at all. Many times, while the professor was lecturing, remote students simply engaged verbally in interaction; they would "shout" questions, interrupting the class continuity.

Within the three seconds, a deep silence followed interruption. Then both student and lecturer would talk at the same time, and then silence again. In these situations, the echo and whatever was said constituted a comedy routine in which no one could really communicate. After many trials, the professor decided to say "Keep talking. Keep talking," thus leaving the impression of disrespect. This raises questions regarding what are the "best practices" in teleconferencing classrooms and how they differ from more conventional settings. Tradition rules of etiquette are also under duress: are we breaking the rules for learning environments due to the communication technology constraints?

Visual Information in the Classroom

> *"I don't know how well they can see me…Sometimes I look at the TV to see what they see of us and I sort of think I look like a dark blob, so I don't really think they can see me too well, so I normally just say something to get their attention"*

Students met every week at the same time, in the same place, and sat in the same location. Each student carefully chose their spot that they respected for all the sessions, during which, I conducted the observations. It was noticeable

that they all chose a seat distant from the other students. They had a need for their "personal space" as participants described during the interviews. Many chose their location, because they wanted to have a good visibility of the remote students in the class. They wanted to have a direct view to the different TVs in the classroom. Usually, they had the tendency to look at the TV that was most directly in front of them, but regardless of how carefully they chose a comfortable position, they had a feeling of being *lost* in the classroom.

Not only did the room feel too big for the class, but also the process of communicating with one another through the information displayed on the TVs was awkward. It was hard to see the presentation/information on TVs from the back of the room. Although it is difficult to see from the back, most of the students chose to sit at the back of the room; possibly to avoid sitting in front and feel intimidation of the instructor, but also to avoid being captured by the cameras.

Students wondered about the remote students in the class. They request more visible access to them.

"It would be good for them to be more visible"

Currently, for students to be "more visible" in this type of learning environment, they need to talk more. Visibility is linked to verbal interaction. In order to be visible in the classroom a student needs to talk to allow the technician to understand, when to place their image on the screen. Thus, verbal communication is the primary interaction that initiates screen presence.

"You have to talk to get on the screen"

"I normally just say something to get their attention"

"Because when somebody's hot they come on full screen"

Observer Tool

The Observer Video Pro (OVP) is a professional software system for the collection, analysis, presentation and management of observational data (see Chapter 6 Observer Pro Video). The software developers recommend the use of OVP for data collection in recording arm movements for usability studies or to study human-machine interaction. Therefore, OVP is a powerful tool for my research in understanding the function of nonverbal communication.

The entire process carried out by the OVP can be summarized in four steps. First, I recorded the observational data from the site by using video cameras. Second, I set-up the observation configuration in OVP (design configuration). The set-up involves creating the variables/values embedded in the study as well as assigning keyboard codes for the observation phase. Third, I observed the subjects, coding the video recordings, which involves assigning the pre-determined key codes or use a mouse click as behavior occurs, while watching the recording. Subjects can be coded individually or all at once. For the purpose of this research, I coded participants individually. That is, I coded 21 observations. When coding, I processed the observations of their behavior in the form of codes according to what was specified in the configuration phase. Lastly, I translated the coded observation into meaningful analytical reports.

After collecting my data in the field, which was digitally video recorded, the next step was to code the data using OVP. The most important part of this process is the configuration. Since this study is exploratory in nature, several attempts were made to define the variables in OVP.

OVP Set-up

I ran the observation in real-time several times to understand the nature of the collected data. From all observations, I selected the most interactive 30 minutes out of the three-hour class, which is labeled by the professor as the "discussion session" for the interactive part of the class. Students were supposed to read a series of papers with the purpose of spending 20 minutes of open discussion with the whole class. After observing behavioral patterns

from the selected portion of the class, I was able to define the OVP variables. The first set-up attempts were extremely focused on coding seamless behaviors. As such, my process of refinement included experimenting with the data.

Criteria for OVP Set-up

OVP was configured based on the proposed framework for the gesture analysis (see Chapter 6 Observer Pro Video Configuration). To recall, the following information is in need of understanding:

1. Gesture-User: who and to whom the gesture is produced
2. Gesture-Context: where (settings) the gesture is produced
3. Gesture-Action: when and how the gesture is produced
4. Gesture-Function: what (meaning) of the produced gesture

In order to answer the above statements, I designed a *screening* method to code data. The overall idea is to filter how the gesture unfolds. First, I identified the delivery channel the participant used to communicate intentions. If there was a presence of nonverbal information (gestures employed), then the next step was to understand its action or the type of gesture used. If the type of gesture was identified, I needed to learn about the direction, to whom the gesture is directed, the hand(s) and space used. The next step was to understand its emotional value, so as to interpret meaning. Lastly, I observed whether the student posture indicated emotions in the gesture performance. This method allowed the coding of items as to the presence or absence of behaviors. As such, for the purposes of understanding gestures in the context of learning environments, five independent variables and eight behavioral classes were defined to code the subject behaviors. Following is the OVP set-up that was employed for coding the observations:

	Values	Description
Independent Variables	*Values that remain constant during the course of an observation:*	
Classroom	Local Remote	Subject location
Environment	Regular	Environment with constant lighting, sound, and temperature
	Irregular	Environment with alterations of lighting, sound or temperature.
Subject	(S1, S2, S3, S4, S5, S6, R1, R2, R3, R4)	Subject under observation
Subject Position	Seating	Subject is mostly seated for the length of the observation
	Walking	Subject is mostly walking for the length of the observation
Behaviors		
Delivery Channel	*The channel used to express an intention*	
State	Gesture-Only	Subject does not include the verbal channel while gesturing
State	Verbal-Only	Subject uses the verbal channel without modifying the current gestural status
State	Gesture+Verbal	Subject includes gestures while talking
State	DC N/A	The researcher cannot record observations, thus delivery channel is not available
SIGs Action	*The form (type) of spontaneous gesture observed*	
State	Raise Hand	Subject raises hand(s)
	Cross arms	Subjects crosses arm(s) and hand(s)
State	Roll Hands	Subject uses hand gestures randomly while talking (such as describing the shape of an object, indicating an imaginary space, etc.)
State	Hand in Chin	Subject places hand(s) in chin or cheek

State	Hand in Mouth	
State	Leaning on Hand	
State	Hiding Hand	Subject hides hands, such as placing hand(s) in pockets, under the table, etc.
State	Physical	Subject uses a sensorial gesture such as scratching, stretching, fixing clothing, playing with hair, etc.
State	Hand Behind Head	Subject places the hand(s) behind the head
State	Hand Movement	Subject moves the finger(s) in a continuous manner, such as tapping, playing with fingers, playing with nails, playing with pen in hand, moving fingers, etc.
State	Instrumental	Subject uses a gesture in complement with an object, such as writing, flipping pages, reading with pen in hand, drinking, etc.
State	Neutral	Subject rests arm(s)/hand(s), such as on the side, table, legs, etc.
State	Other Action 1 (Pointing)	Subject uses regulatory gestures, such as directing, indicating.
State	Other Action 2 (Locking Fingers)	Subject uses *locking* gestures such as weaving the fingers together, while seated.
State	Other Action 3	Left to gesture actions that cannot be coded.
State	A N/A	Gesture is not available for coding

SIGs Direction	*To whom the gesture is directed*	
State	Oneself/None	Gesture does not have a direction, thus is directed at oneself

State	A Person	Gesture is directed at a single person
State	Group	Gesture is directed at several people
State	Something	Gesture is directed at an object
State	D N/A	Direction of gesture is not available for coding
SIGs Hands Used	*Location and hand(s) employed to produce the gesture*	
State	1 Hand Low	One hand is used to produce a gesture below the chest
State	2 Hands Low	Two hands are used to produce a gesture below the chest
State	1 Hand Middle	One hand is used to produce a gesture between the chest and head
State	2 Hands Middle	Two hands are used to produce a gesture between the chest and head
State	1 Hand Upper	One hand is used to produce a gesture above the head
State	2 Hands Upper	Two hands are used to produce a gesture above the head
State	H N/A	Hand used is not available for coding
Emotional State	*Subject perceived emotional state*	
State	Neutral/Calm	Subject shows almost no signs that can be classified, which can be associated with calmness, relaxation, and slowness.
State	Anxious	Subject shows signs of being nervous, rapid, sudden, uncomfortable, etc.
State	Confident	Subject shows signs of being certain, convinced, sure, aggressive, forceful, motivated, etc.

State	Insecure	Subject shows signs of being unconfident, timid, doubtful, hesitating, unsure, etc.
State	Interested	Subject shows signs of being engaged, involved, concentrated, fascinated, etc.
State	Bored/Tired	Subject shows signs of being uninterested, distracted, indifferent, etc.
State	Positive	Subject shows signs of agreement, being certain, content, satisfied, happy, etc.
State	Negative	Subject shows signs of disagreement, being unsatisfied, mad, angry, etc.
State	Other Emotion 1	Subject shows signs of being some emotion that does not fall into the previous categories.
State	E N/A	Emotional state is not available for coding
Subject Posture	*Subject spinal position*	
State	Straight	Subject position is straight
State	Leaning Front	Subject position is leaning forward
State	Leaning Back	Subject position is leaning back
State	P N/A	Posture is not available for coding
Intervention	*Type of interaction*	
State	P Lecture	A local professor is moderating/lecturing the class
State	PR Lecture	A remote professor is moderating/lecturing the class
State	S Lecture	A student, either remote or local, is moderating the class

Event	P Ask Question	A professor, either local or remote, asks a question
Event	S Ask Question	A student, either remote or local, asks a question
Event	O Ask Question	Someone other than a student or a professor asks a question
State	I N/A	Intervention not available for coding
Media	*Multimedia materials supporting the teaching experience*	
State	Slide	A slide presentation is used for lecturing
State	Elmo	A projector is used for lecturing
State	Video	A video recording is used for lecturing
Event	Change	Change occurs in the media material, such as changing a slide.
State	None	No media is used for lecturing
State	M N/A	Media is not available for coding

Table 1: Observer Video Pro Set Up

There are two types of coding in OVP: states and events. *States* were used to describe and record behaviors that take place over a period of time, such as prolonged activities. *Events* were used to describe and record behavior that only takes an instance of time, which could be counted. In this final configuration, most of the values are states. In few cases, especially in items the intervention and media behavioral classes, events are used. For example, "change" is an event value that represents a change of a presentation slide, during the class or a professor asking a question. These instances can be quantified and the effect on gesturing and participation could be described.

Findings from preliminary OVP configuration

I attempted several times to configure OVP and arrive at refined concepts. Originally, I developed it as a configuration in which students were observed/coded in groups in contrast to the current configuration which

students were coded individually. In order to do group observations, there was a need to create *channels* of interaction of variables and subjects. If I were observing seven subjects within eight behavioral classes, I would need 56 channels. Current OVP software has a limited number of channels to be used. Since my research explores many aforementioned items, this coding style was discarded.

A number of other problems arose, such as coding all items, as events, so as to quantify the behavior. However, richer data can be analyzed by coding items, as states (e.g. we can understand if an emotional value can be shared within the length of gesture actions). Before this, behavioral classes to code and match gestures produced by the student were missing. Also, I found that certain coding were irrelevant due to the invariability of the results. Therefore, I modified the description of the gesture's action behavior to record a wider range of hand gestures utilized in the classroom environment.

I removed the behavioral classes of classroom environment (settings) and student distance for the analysis, since neither showed change throughout the class. All students were seated in the same place for the entire class, within a *social distance*, a term used by (Hall, 1966).

I dropped several other behavior items from my coding, because they added complexity to the coding experience. For example, before I had a behavior that coded the visibility of gestures, but I removed this gesture visibility from the analysis because all gestures utilized by the students were highly visible except for a few cases, such as when a student placed their hands in a pocket. I added a new category of gesture action to compensate for the analysis of these type of gestures.

Another behavior that I dropped was the behavioral class gestures type. The aim of this behavior type was to classify gestures based on McNeill's gesture categorization. I observed that the majority of gestures utilized by students did not fall under any of those categorizations. Even though on certain occasions students made use of pointing gestures, the majority were found to be first, an "other type" of spontaneous gestures, such as leaning on the hand; second, physical gesticulation gestures, such as scratching; third, instrumental

gestures, such as writing; and lastly, baton gestures, such as rolling the hands. Emblem, iconic and metaphoric gestures were never used.

Lastly, in the beginning I wanted to understand the performance of gestures in the classroom environment, such as they are produced alone or by cooperation. This behavior analysis was removed from the coding, because it was apparent that there were no cooperative gestures (the type of gestures that are completed, when involving another person, such as hand shaking). Also, there was another behavior set-up to understand, if a gesture had a sequence, in which a gesture was followed by another gesture to complete the first gesture (e.g. the gesturer starts scratching on their head and later moves to the neck). It was apparent that the majority of the gestures were independent. Moreover, the study of dependency and independency of gestures can be acquired from the gesture actions behavioral class analysis.

Findings

Student Experiences and Needs in Teleconferencing Environments

When I asked the students what the function of attending this class was, they answered:

> *"My function is to learn. To learn and to participate in ways that stimulate conversation"*
>
> *"I am there to learn from a lecture and then participate in the discussion"*

I further asked what they meant by participation. Many students answered in terms of engaging in discussion, raising questions, etc. What was interesting is that, while explaining the term, participants made a gesture of moving/rolling the hands to indicate active participation or raise a hand to indicate the act of asking for questions.

> *"As far as lectures are concerned, I don't think there is a problem. As far as asking questions, discussion is hard, because number one there is delay. So if you ask a question, the person keeps talking. Takes a while for the question to get there…and yeah! That's pretty much it. I think there is also a problem with the presence - with the professors there to learn better, when I can see him rather than having the screen with the PowerPoint…"*

> *"I have a hard time processing information, if I am only receiving it orally and not visually…"*

Based on their answers, it is apparent that interaction leads to the learning experience. For the majority of the students, this was a first time experience in a teleconferencing class. Several showed a dislike towards this type of learning environment. They showed positive feelings towards the content, but negative feelings were prominent towards the unsatisfactory communication interaction used. Rapid feedback and visibility of other students was a crucial need for building connections, and thus interactions.

> *"The distance people…I don't really think about them that much. Although I should. But it is kind of out of sight, out of mind"*

This comment poses the need for visibility in communication at a distance. Since remote students are not as visible to the local students, they tend to ignore the remote students. Visibility is a key component to build a better presence. Being in sight aids and facilitates recognition/inclusion of people in one's perception, rather than merely having a single verbal channel of information.

> *"The funny thing with this class is that you have to be sure and speak loud so other people can hear you and also make sure that your question lasts long enough to direct the camera to you sort of…to interrupt the audio feed so someone can hear your question…"*

"It just feels very…ah…disjointed and I have to be very proactive in…participating or paying attention"

Rapid feedback and visibility seem to affect the student's engagement and thus participation in the learning environment. Not having rapid feedback inhibits the student from engaging in participation. If the student has a comment to make and tries to participate, then the discussion shifts, and their input into that discussion comes in late, missing the opportunity to participate. Visibility of the message appears to add confidence to the understanding of the ongoing discussion. It helps to extend the auditory learning. Linking visibility and rapid feedback is the premise of face-to-face communication.

The important point here is that with the current interaction mechanism participants are adapting to the technology (rather than the reverse). The majority found that they needed to be "rude" and change formal manners, because of the technological mediation. Moreover, there was a lack of signals to moderate the conversation. So far, they could only use a verbal mechanism like saying "question" to signal the need to talk. These issues prove the need for more fluid natural mechanisms that support human-to-human communication mediated by computers.

Gestures in Learning Environments

In the next sections, I will describe the student experiences according to my observations and interviews with the enrolled students in the class. I have limited my observations and interviews of student-to-student interaction. There are different interaction levels that are subject to roles in the learning environment. Therefore, focusing on the student interaction only avoids variability and misinterpretation of research observation results.

Classmates Gestures Awareness

When I asked interviewees about their perception of gestures, the majority responded that they are somewhat aware of other student's gestures, but cannot recall the type of gestures due to an unconscious processing of the

visual information. They stated that movement in a person draws more of their attention. Moreover, when they spoke about their classmates, they related gestures with being more active. As such, at their assessment, a person who gestures is perceived to be more active than a person who does not gesture. For example, when interviewees were referring to a classmate who was passive, they demonstrated a gesture such as leaning back with the hands resting on the side. Whereas, for a classmate who was active, they demonstrated a gesture such as leaning forward and the *rolling hands* type of gesture. However, when talking about the remote students, it was difficult for them to recognize gesture production. The reasons explained included that they cannot really recall the type of gestures produced by the remote students, either because they are not visible or they do not gesture directly at them.

Delivery Channels Used

From the coded observations, 93.8 % of all of the delivery channels used are gestural only. Less than 1% used only the verbal channel, while talking without modifying the current gestural status. The final 5.7% used the gestural and the verbal channels jointly. Regardless, that this class is a discussion type of class, students were able to verbally participate less than 6% total in the class. The point here is that the student can be participatory without verbally engaging in the classroom.

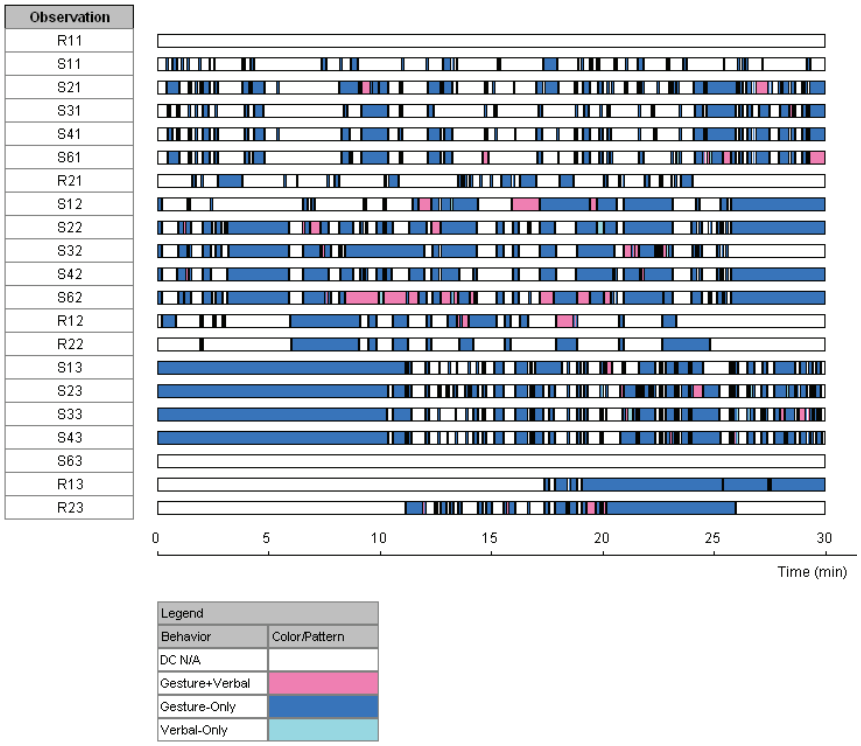


Table 2: Delivery Channels Used

Gesture Performance

When looking at the gesture direction, 94.9% performed the gesture towards their self (oneself), and the rest of the total was shared among a person, group and something (i.e. pointing to something).

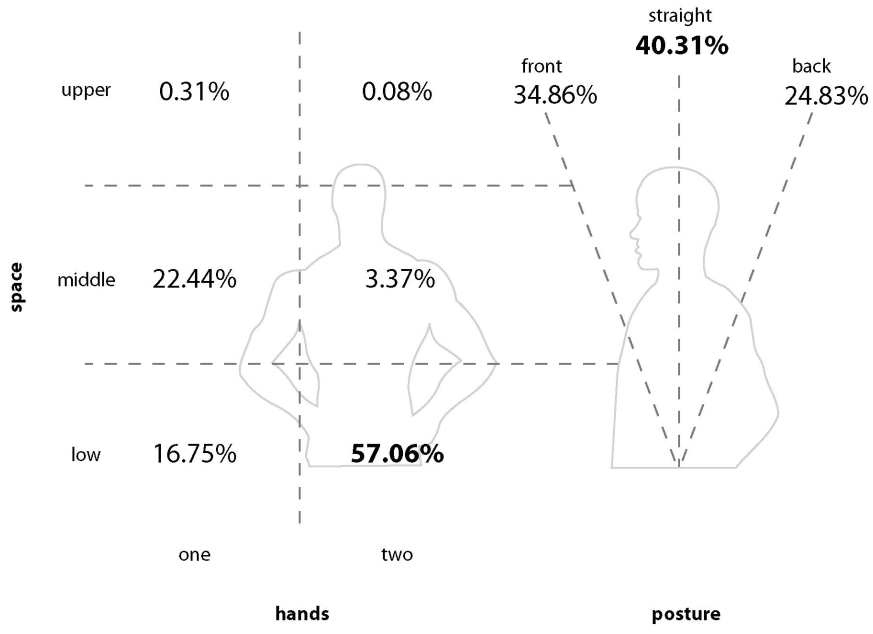


Figure 19: Hand(s), Space and Posture Used

"What About the Distance People?"
Is there a difference in the use of gestures between the local and remote students?

Results are similar for both local and remotely located students. While local students use 92.1% of the gestural channel for all the direct observations, the remote students use 95.5%. Remote students did not use the verbal channel alone at all. These results tell us that the remote students tend to gesture more and talk less in this type of environment.

The above diagram visually describes my direct observations in the learning environment. Now, that I have found that the prominent delivery channel is the gestural, I wonder what the 93% of nonverbal information tells us.

In the following section, I will talk about each subject individually by explaining descriptions of their performance through the different measures.

Subject Descriptions

The Neutral Student
S1 Group of Observations

"He tends not to gesture, he sort of sits there and he processes"

I was able to observe this participant for a total of 43% of my observations, which are around 39 minutes. For the length of my observation this participant used principally the gesture-only delivery channel (94%), in which the majority were executed to oneself (94%). From all gesture actions, the participant used the instrumental (28%), neutral (20%) and hand on chin (20%) the most. The duration of these gestures ranged between a minimum of 0.73 seconds to a maximum of 132.33 seconds, with an average of 13.74 seconds and rate of 0.44 gestures per minute. Results indicate that the majority of the participant's emotional states showed interest (78%) by having mostly a straight posture. From all participants observed, S1 used the hand on chin gesture the most.

The Active Student
S2 Group of Observations

"She will put her hands on the table prepared to do something"

I was able to observe this participant for a total of 59% of my observations, which are around 53 minutes. For the length of my observation, this participant used principally the gesture-only delivery channel (93%) in which the majority were executed to oneself (95%). From all gesture actions, the participant used the neutral (37%) and instrumental (22%) actions the most. The duration of these gestures ranged between a minimum of 0.37 seconds to a maximum of 66.5 seconds, with an average of 17.5 seconds and a rate of 0.88 gestures per minute. Results indicate that the majority of the participant's emotional state showed interest (43%) and neutrality (33%). Also, from all participants observed, S2 used the physical gesture the most, and was the participant, who used a straight posture the most.

The Instrumental Student
S3 Group of Observations

"She just sits there and thinks about things"

I was able to observe this participant for a total of 50% of my observations, which are around 45 minutes. For the length of my observation this participant used principally the gesture-only delivery channel (93%) in which the majority were executed to oneself (96%). From all gesture actions, the participant used the instrumental (38%) and neutral (33%) the most having mostly a leaning front posture. The duration of these gestures ranged between a minimum of 0.5 seconds to a maximum of 60.1 seconds, with an average of 11.4 seconds and a rate of 0.93 gestures per minute. Results indicate that the majority of the participant's emotional states showed interest (63%), being the most salient from the group. Also, from all participants observed, S3 used the instrumental gesture the most.

The Indifferent Student
S4 Group of Observations

"I think the real people in our class don't have any problem participating, besides the one person that sits in the back"

I was able to observe this participant for a total of 54% of my observations, which are around 49 minutes. For the length of my observation this participant used principally the gesture-only delivery channel (99%) in which the majority were executed to oneself (99%). From all gesture actions, the participant used the leaning on hand (32%) and cross arms (12%) the most. The duration of these gestures ranged between a minimum of 0.56 seconds to a maximum of 261.2 seconds, with an average of 28.4 seconds and a rate of 0.31 gestures per minute. Results indicate that the most of the participant's emotional states showed boredom (47%). Also, from all participants observed, S4 used leaning on hand and cross arms the most, and was the participant who showed boredom the most.

The Confident Student
S6 Group of Observations

"He looks both like too relaxed to be engaged and then all of a sudden he is Mr. Aggressive"

I was able to observe this participant for a total of 37% of my observations, which are around 33 minutes. For the length of my observation this participant used principally the gesture-only delivery channel (77%) in which the majority were executed to oneself (84%). From all gesture actions, the participant used the instrumental (22%), neutral (21%) and hand movement (18%) the most. The duration of these gestures ranged between a minimum of 0.57 seconds to a maximum of 93.1 seconds, with an average of 16.86 seconds and a rate of 0.27 gestures per minute. Results indicate that 43% of the emotional state showed interest (47%) and neutrality (19%) the most. However, from all participants observed, S6 used the roll hands gesture the most, and was the participant, who showed confidence the most.

The Anxious Student
R1 Group of Observations

"He looks like he is being police interrogated"

I was able to observe this participant for a total of 24.5% of my observations (significantly less than the local students), which are around 22 minutes. For the length of my observation this participant used principally the gesture-only delivery channel (93%) in which the majority were executed to oneself (93%). From all gesture actions, the participant used the neutral (31%) and hand movement (29%) the most. The duration of these gestures ranged between a minimum of 1.5 seconds to a maximum of 63.47 seconds, with an average of 17.7 seconds and a rate of 0.25 gestures per minute. Results indicate that the majority (62%) of the participant's emotional states showed interest having mostly a straight posture. However, from all participants observed, R1 used the hand movement gesture the most.

R2 Group of Observations

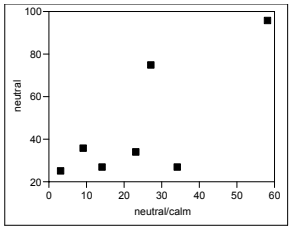
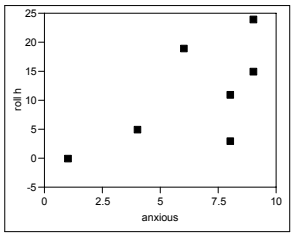
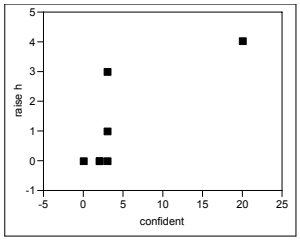
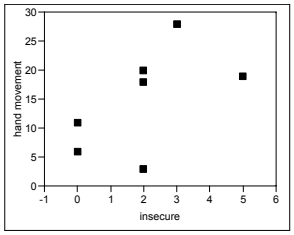
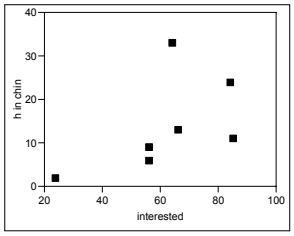
I was able to observe this participant for a total of 27.5% of my observations (significantly less than the local students), which are around 27 minutes. For the length of my observation this participant used principally the gesture-only delivery channel (97%) in which the majority were executed to oneself (98%). From all gesture actions, the participant used the neutral (41%) and instrumental (27%) the most. The duration of these gestures ranged between a minimum of 0.47 seconds to a maximum of 75.9 seconds, with an average of 13.11 seconds and a rate of 0.44 gestures per minute. Results indicate that the majority (62%) of the participant's emotional states showed interest having mostly a straight posture.

The Role of Emotion in Gestures

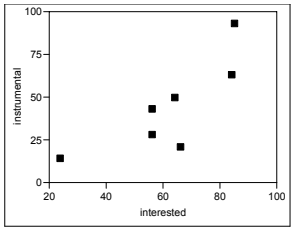
I observed many students being anxious, interested, insecure and many other demonstrations of emotions. In fact, by observing I was able to code each student through the range of emotions they demonstrated during the observations. Recall that my coding biased on *screening*. As such, the student emotions were observed separately from other measures.

Though I could subjectively say, for example, that students may feel more anxious or nervous, while talking when rolling hands than crossing arms, I decided to have a more objective approach, based on the observation results from OVP.

I used a bivariate analysis to find the correlation of the gesture action (Y) with emotion (X). With a bivariate normal ellipse P=1.000, I found *strong correlation* of the following measures:

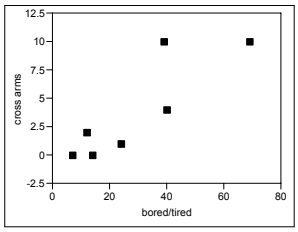
Analysis	Graph	Correlation
Bivariate Fit of neutral By neutral/calm		0.769497
Bivariate Fit of roll hand By anxious		0.641958
Bivariate Fit of raise hand By confident		0.790967
Bivariate Fit of hand movement By insecure		0.560473
Bivariate Fit of hand on chin By interested		0.536747

Bivariate Fit of instrumental
By interested



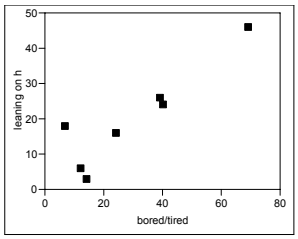
0.800759

Bivariate Fit of cross arms
By bored/tired



0.862695

Bivariate Fit of leaning on hand
By bored/tired



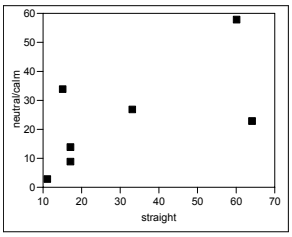
0.908656

Table 3: Gesture Emotion Correlations

Results indicate that beyond the gesture action there are emotions that drive the meaning of the gesture. In other words, the emotional aspect of a student may impact the gesture performance during the class. As such, by understanding the meaning of a gesture, we may recall how the student might feel throughout the class dynamics.

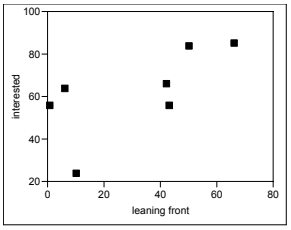
In the same fashion, I use analysis to understand how emotion correlates with a student's posture. Following are the results:

Bivariate Fit of neutral/calm
By sitting straight



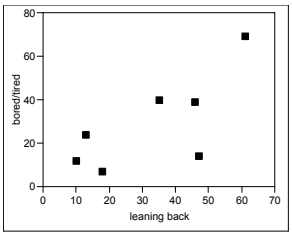
0.637393

Bivariate Fit of interested
By leaning front



0.680605

Bivariate Fit of bored/tired
By leaning back



0.735334

Table 4: Emotion Posture Correlations

As the results indicate, there is strong evidence of a correlation of student's posture with certain emotions. These findings confirm one of the first researchers on gestures (Ott, 1902). Student posture may tell us about the emotional status of the student, thus linked to the gesture performance.

Gesture Classification

In this section, I will explain the gestures I found in the context of learning environments. Below, are diagrams that visualize both the type and amount of gestures performed, based on the OVP configuration, and how those gestures were performed by the students in my observations:

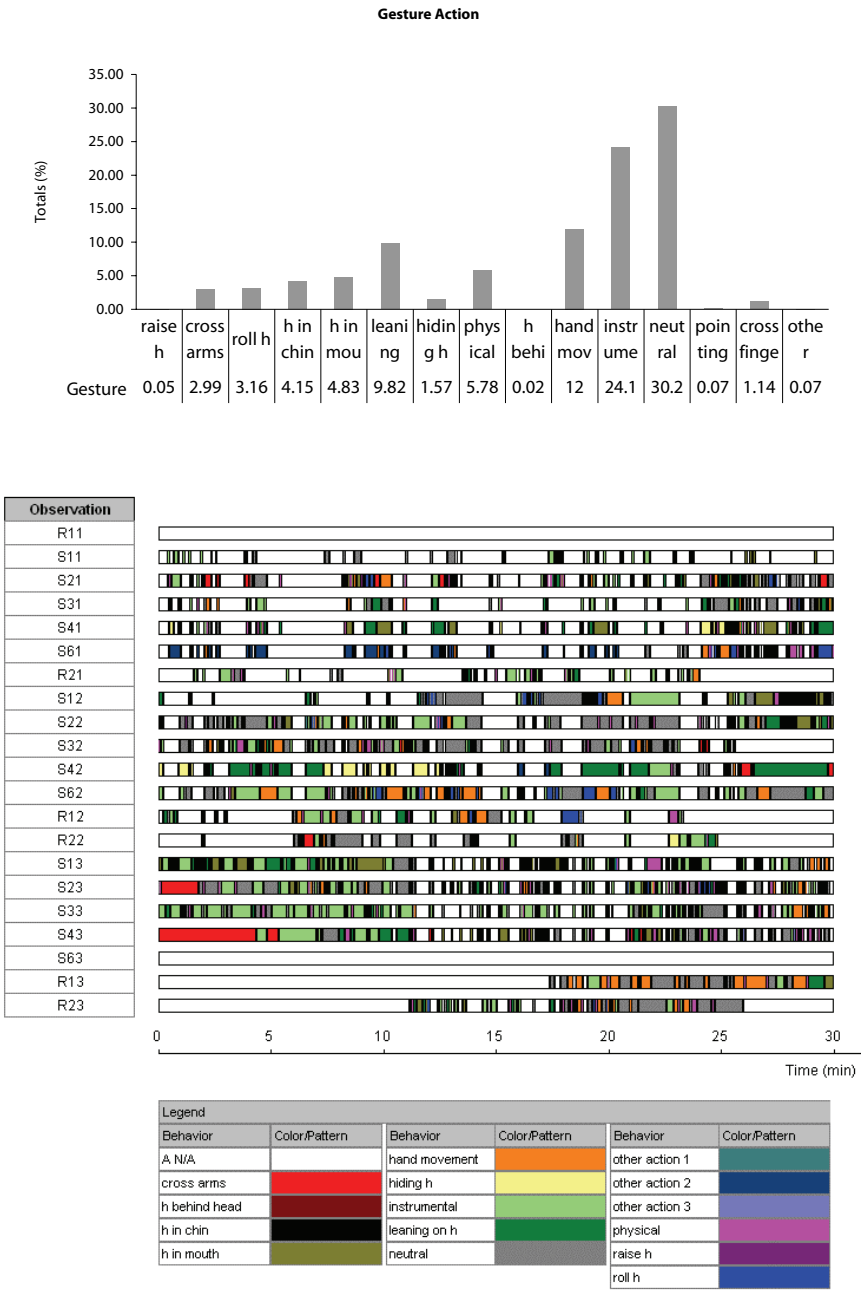


Figure 20: Gesture Actions Graphs

Question! Count Me! Help!
Raised Hand Gesture

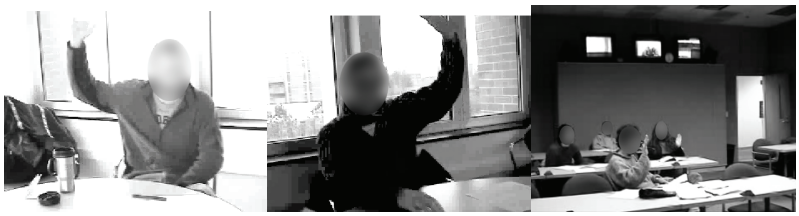


Figure 21: Raised Hand Gesture Demonstration

One hand, either left or right with the palm open, is extended upward. From the observations, raising hand constituted only 0.05% of all the gesture uses. This multifaceted gesture holds different meanings in the context of learning environments. One of its representations is asking for attention. Though this gesture was not used frequently in the learning environment (observations), all interviewees responded that they would raise the hand prior to asking a question to the group. Accordingly (Armstrong & Wagner, 2003), this gesture meaning is mainly accepted in Western culture.

"I would probably just raise my hand, if I were going"

Raising the hand can also represent the act of giving positive feedback. It serves as a counting device for the professor. The student may raise the hand to answer "yes" to a professor's question. Finally, this gesture represents requesting help. However, when help is requested, the performance of this gesture slightly varies by decreasing the extension of the arm. The shape of this gesture resembles the act of build and construct, in this specific case, to stand out from a crowd.

A Barrier for Learning
Arms Crossed Gesture

Figure 22: Crossed Arms Gesture Demonstration

The arms are crossed/folded and held close to the chest, while hands may sit under the armpits. From the observations, crossing arms constituted 3% of all the gesture use. This gesture represents "a self-comforting, self-stimulating posture, unconsciously used to alleviate anxiety and social stress," which is often decoded as a defensive barrier sign (Givens, 2005). (Armstrong & Wagner, 2003) also defines it as defensive to intimidate and exclude people from a group especially used by guards setting up a barrier. In the context of learning environments, this gesture represents exclusion and disinterest. The cross arms/hands position is comfortable for the gesturer to counteract the pain caused by the dislike of an ongoing situation.

Rollin' Without Moving
Rolling Hands Gesture

> *"I go like this a lot or like this ...yeah, you know, the new trees are cycling around, then they come back. I got to the tree, and the tree's leaves fall to the ground and the bacteria breaks down the nutrients. Like the tree goes to here ... its unconscious"*

Figure 23: Roll Hands Gesture Demonstration

The hands are randomly moved in the air at the chest level. From the observations, rolling hands constituted 3.16% of all the gesture use. This gesture is a baton type of gesture (McNeill, 1992). This gesture is mainly employed as an unconscious bit of body language, gesticulating while talking. When interviewees were asked to define active participation, the majority started using this gesture. Students roll their hands with direction both when looking at papers engaged to one's own direction, and when looking at people expressing ideas. The meaning of this gesture confirms the Goldin-Meadow (2003) theory that serves as a tool for thinking, such as moving the hand while developing ideas, and a tool for listeners, as the hand movement completes the verbal channels. I found that this gesture was performed using one or two hands at a time, even when holding objects in one of the hands. As such, this gesture is a dynamic point in holding an argument or to illustrate a definitive point in conversation, such as when one hand chops the other hand to represent finalizing a point (Armstrong & Wagner, 2003); palms up hand gestures to represent uncertainty (Givens, 2005); grabbing a virtual ball to represent wholeness, etc.

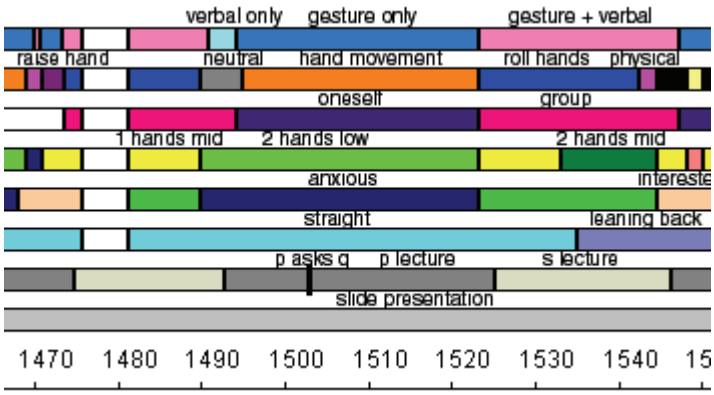


Figure 24: Roll Hands Gesture Observation Graph

'The Thinker' by Rodin

Hand on Chin/Cheek Gesture

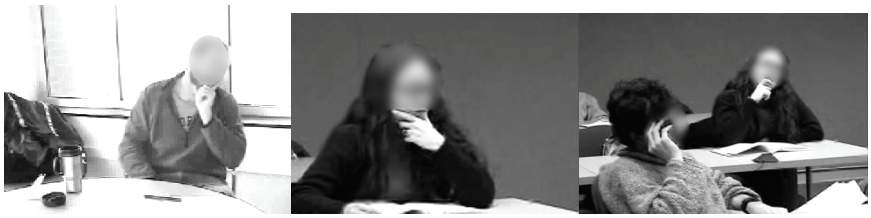


Figure 25: Hand on Chin/Cheek Gesture Demonstration

A single hand is placed, usually, with the thumb and forefinger scraping the sides of the chin or cheek. From the observations, hand on chin or cheek constituted 4.15% of all the gesture use. This gesture is used unconsciously to represent, when someone is deep in thought in the context of learning. Hand stimulation on the face used in the classroom environment may indicate that the student is thinking about the discussion topic. According to (Armstrong & Wagner, 2003) this gestures originates from stroking a grown beard, a sign of maturity. The gesture hand on chin was used frequently, especially when reading papers during the open group discussion. Along with the gesture, other nuances just as tilting the head or using the eyebrows may indicate uncertainty. On certain occasions, the hands were placed on the forehead. However, this slightly modified gesture was used to convey the same meaning of being uncertain and in deep thinking.

Holding Thoughts

Hand in Mouth Gesture

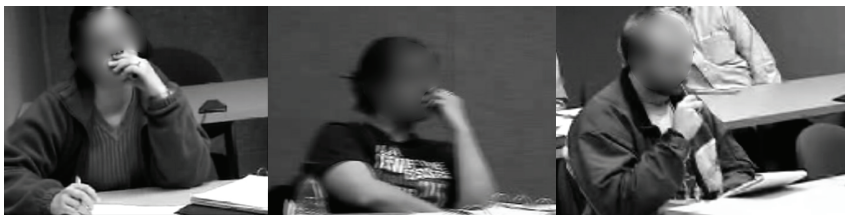


Figure 26: Hand in Mouth Gesture Demonstration

Hand(s) plays/moves over the mouth (lips) area, and objects are also often involved. From the observations, leaning on hand constituted 4.8% of all gesture use. This gesture was used unconsciously, when students were engaged in deep thinking. This gesture serves the same function as rolling the hands, while talking. However, this gesture is directed at one's self and produced without the verbal channel. Both gestures, rolling hands and hand in mouth, serve as a tool for thinking. Having the hands in mouth helps to stimulate thinking and physically produces a movement that synchronizes with the ongoing thinking processes. Often professors would look for the presence of behavior, such as pen in mouth, to judge whether help is needed (Neill, 1991).

Weighing Waiting

Leaning on Hand Gesture

Figure 27: Leaning on Hand Gesture Demonstration

One or two hands serve as structures to support the weight of the head, where the elbow is the surface point and the hand the holding point. From the observations, leaning on hand constituted 9.8% of all gesture use. This gesture is used unconsciously to simply rest.

Behind the Scenes
Hiding Hand(s) Gesture

Figure 28: Hiding Hands Gesture Demonstration

Hand(s) are not directly visible, usually hidden in pockets or behind other immediate objects. From the observations, leaning on hand constituted 1.6% of all gesture use. This gesture is used unconsciously to represent the need for escape. This gesture is used as a variation of crossing arms, both being defensive types of gestures. Again, the purpose of these gestures is to create a barrier of signals often linked to uncertainty and lack of confidence (Neill, 1991). One possible variation of this gesture is to combine it with leaning on hand gestures.

Wake Up Call
Sensorial-Physical Gesture

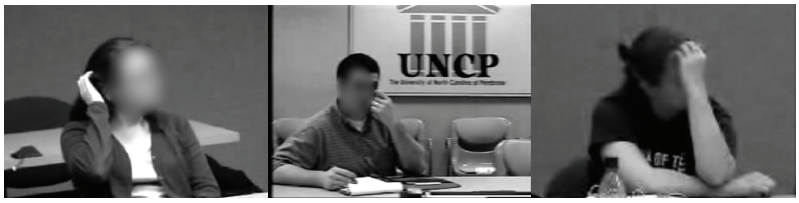


Figure 29: Sensorial-Physical Gesture Demonstration

Hand(s) are used to scratch or pinch different parts of the body. From the observations, leaning on hand constituted 5.8% of all gesture use. This gesture is used unconsciously, establishing physical contact with one's own clothing or body parts; e.g. hands on face is the act of stimulating one's own tactile receptors for pressure, vibration, heat, cold, smoothness or pain (Givens, 2005). Armstrong describes that we unconsciously touch our bodies

when emotions run high to comfort, relieve or release stress. As such, one can say that when performing this gesture, the sympathetic nervous system might be activated. This gesture was often used as a self-stimulating behavior during the lectures. That is, the majority of the students were using it after being bored/tired and previously demonstrating interest with gestures, such as hand on chin. On certain occasions, students scratched the head, which can be understood as confusion or bemusement or trying to solve a problem (Armstrong & Wagner, 2003). In any case, this gesture is used to self stimulate the gesturer in placing more attention on the topic under discussion.

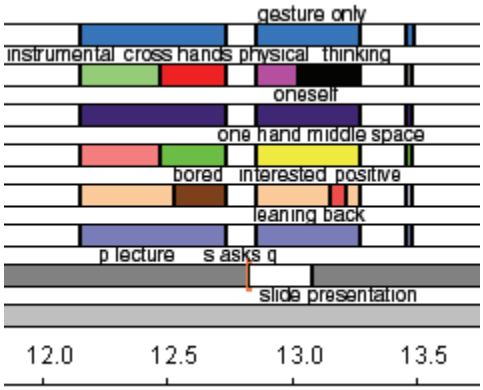


Figure 30: Sensorial-Physical Gesture Observation Graph

Maintain Structure

Hand Behind Head Gesture

Figure 31: Hand Behind Head Gesture Demonstration

Hand(s) are placed holding the back of the neck or head with the opened palm, while elbow(s) open out. From the observations, hand-behind-head

constituted 0.02% of all gesture use, being the least used gesture. This gesture is used unconsciously to represent uncertainty, which usually reflects negative feelings. In a conversation, hand-behind-head also may be read as a potential sign of conflict, disagreement, frustration, anger or dislike (Givens, 2005).

Handling Thoughts

Hand Movement Gesture

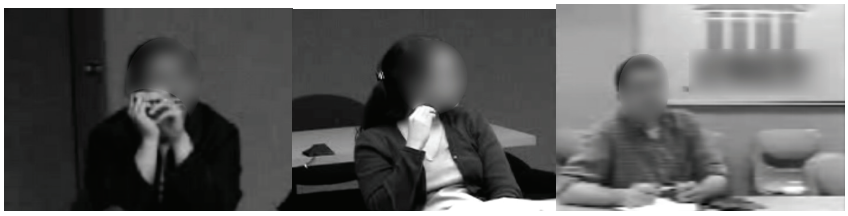


Figure 32: Hand Movement Gesture Demonstration

One or two hands move continuously with or without objects. From the observations, hand movement was used 12% of all gesture use, being the third most-used gesture in the classroom. This gesture is used unconsciously within the same parameters of hand in mouth. That is, the movement of the hand, either by rubbing the hands, playing with objects in the hand or playing with nails, serves as a thinking tool for the gesturer. On certain occasions the constant movement of the hand may indicate boredom, especially when having objects in the hand. As Richmond (1992) states, a student is constantly tapping a pen on the desk, when nervous, bored, trying to annoy the teacher, and often is unaware of tapping the pen. This gesture is directly linked to an emotional state of anxiety.

Note Write – Ghost Write

Instrumental Gesture

Figure 33: Instrumental Gesture Demonstration

One hand holding a pen is used to engage in the activity of writing. From the observations, the instrumental gesture constituted 24% of all gesture use, being the second most used gesture in the classroom. This gesture is used unconsciously and demonstrates active participation in the class, in the sense that the student is engaged and interested in the topic under discussion or feels compulsion to take notes. The student engages in writing what appears to be of interest to them. However, as one of my interviewees stated, this gesture may also be used to demonstrate boredom. I noted that when the student was engaged in the topic, he or she would be in a straight position writing for an extended period of time, and mostly using both hands at the lower level. One hand would be used to write and the other to keep an attentive posture in place. In contrast, the opposite meaning of this gesture would be shown when leaning back and using mostly one hand to write. The other hand would be used to lean, to scratch or to play with objects in the immediate environment.

Make Me Look Unavailable

Instrumental Gesture

Figure 34: Instrumental Gesture Demonstration

Although the instrumental gesture was used mainly to demonstrate active participation and engagement in the class, it also showed the opposite: disengagement in the classroom. The question that arises is how can we differentiate one intention from the other within the same gesture? The answer is the frequency of the movement, timing and emotion. Jerky, sudden movements may reveal emotional states such as anxiety, that when linked to this gesture reveals the need of finding alternative tasks (e.g. flipping pages) to escape from the current state. As such, emotions play an extremely important role in gestural meaning.

Neutral Gestures

Figure 35: Neutral Gesture Demonstration

Arms are set on the side of the body with the hands resting on the legs, an armrest or the table. From the observations, the neutral gesture constituted 30% of all gesture use, being the most used gesture in the classroom. This is considered a comfortable, attentive and passive gesture, which is used when

the student shows signs of being calm. As such, this gesture possesses null cues.

Regulatory

Pointing Gestures

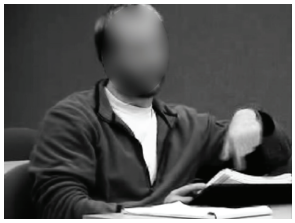


Figure 36: Pointing Gesture Demonstration

Hand(s) are used to indicate the location of something/someone, either physical or virtual. From the observations, pointing constituted 0.07% of all gesture use. Unlike situations in other contexts where this gesture could be impolite, considered sometimes a threat and confrontation (Armstrong & Wagner, 2003), in learning environments it is only used as a regulatory, directional gesture to assume dominance in conversation.

Crossing Fingers

Figure 37: Crossing Fingers Gesture Demonstration

Hand(s) are interlocked, while resting on the legs. From the observations, pointing constituted 1.14% of all gesture use. This gesture is performed similarly to the neutral gesture. However, its meaning may vary significantly. In contrast to having palms up with the act of giving and receiving, the student interlocks the hands to unconsciously state a private space and the

act of only getting information. Thus, the student *locks* the information received. This gesture is also associated with emotions in the sense that while palms up is a non-aggressive and vulnerable gesture (Givens, 2005), locking hands down represents dominance and confidence.

The Beat of Affirmation

Nodding Gesture

> *"I'll nod if the professor's looking at me. (I ASKED: what happens if the professor is not looking at you?) Maybe I'll nod to myself"*

The head moves up and down slightly, with short but continuous movements. Showing certainty and understanding is an important measure in learning environments. Although this research focus is on hand gestures, I would like to introduce this head gesture, which conveys the meaning of certainty, or understanding, in addition to hand gestures.

Usually, a professor asks short questions such as: "can you see that?" while talking about a graph. Students do not answer the question verbally but, instead, use small nods and smiles to demonstrate certainty. It is a type of gesture related to the "yes" gesture, used to convey the meanings of "yes, yes", "it makes sense", "I get it", or "I understand".

If the professor does not ask a question, students perform the nodding gesture to demonstrate engagement. Their nodding synchronizes with the *rhythm* of the professor's phrases. The gesture's shape conveys the meaning of "I am following you" by giving a short affirmative nuance that allows the professor to keep going with the current topic.

Discussion

The Interface Stagnation

"Hello...hello...can you hear me?
Move your hand, if you can see me..."

Digital communications have changed many aspects of our lives. Computers continue to increase in effectiveness, since first introduced to the market around 1930. They are extremely and comparably faster, allowing people to make the seemingly *impossible, possible*. Yet, in 2005, we still have difficulty communicating at a distance on very basic levels.

What is wrong with this picture?

One of the first media visionaries once stated, "the medium is the message" (McLuhan, 1964). There have been many interpretations of this phrase. It is consistent that the mechanism--interface is the message--output. The problem of communicating at a distance relies on the interface stagnation we encounter, when communicating through computers. Our communication becomes mediated, and therefore, controlled and limited, and away from being natural. Humans should be the natural interface without any mediation to communicate at a distance.

I conducted fieldwork/observations in a Distance Education course at NCSU that uses teleconferencing technologies to communicate to one another. I was an observer of the class as the interaction unfolded. During my observations, I discovered that there are interpreters in the classroom (technicians) mediating the communication; the communication interaction is disruptive; the visibility spectrum is limited and necessary; and prompt feedback is an essential component to stimulate student participation. The results confirm that the overall experience is negative due to the lack of an efficient mechanism that allowed the class to fluently communicate in terms of the faster transfer of information. There is a need for mechanisms that are less disruptive, avoid delay, allow rapid feedback and bring a better presence of the social self. In other words, in order to take the distance out of the

current systems is to incorporate the effective face-to-face communication, in which gestures play a determinant role.

All presented gestures were found in the learning environments I observed. In summary, the gesture vocabulary, I present, demonstrates the intensive use of unconscious production of hand actions. That is, spontaneous production of hand gestures that represent different meanings. The meaning was never outspoken, rather it was inherent in the symbolic and physical representation of the gesture. Further, it is physically subjected to the student's emotional state and posture. Having an understanding of these movements in the classroom environment creates an opportunity to gain extra communication channels besides verbal; one can understand the complexity in the classroom environment, especially when dealing with a large number of students at once, and allow one to manage the learning situation to influence and improve the student experience.

As I have shown with the recorded observations and analysis in OVP, gestures are a part of almost all of our cognitive and emotional communication in the classroom. Gestures should not be discriminated in these environments. Rather, the fruitful use of their occurrence should be celebrated.

Designing Mechanisms that Help People Engage in Participation

Phase one of this project is a great collection of data towards validating the purposes of my research. It validates my research points of the need of designing mechanisms that promote participation. Gestures are powerful tools, but not visible enough for efficiency, when incorporated in Distance Education. The key, again, is to reduce the time lag and make the environment more interactive, more fluid. The purpose is to "get the meaning right away." Augmenting the meaning of messages is an approach to facilitate interaction by improving rapid feedback and accelerating the transfer of the message to the other "far away" side of the interaction.

Grounded Experimental Variables
Criteria for the Selection of Participatory Measures

Four different gestures have been extracted from fieldwork for the experimental analysis:

- Raise hand
- Roll hands
- Hand on chin/cheek
- Cross arms

The criteria for selecting the aforementioned gestures were based on the contrasting characteristics of each. That is, the visibility of raising one's hand can be widely differentiated from crossing arms, whereas hand in mouth and hand on chin cannot easily be differentiated. Also, the emotional aspects of the gesture were taken into account. The selected gestures have strong correlations with the emotional aspects of a person. Crossing arms is highly correlated with boredom; hand on chin with interest, etc. Finally, selecting gestures that are less ambiguous in meaning was taken into account. Crossing arms holds a single meaning, as opposed to most hand movement gestures. However, raising hand was selected to test the duality of hand gestures. In the next section, I present findings of the performance of the selected gestures under different conditions.

Phase Two
Quantitative Experimental Research Findings
Nonverbal Evidence in Classroom Participation

The Phase Two of the research project aims to test how participants process nonverbal information. The purpose is to investigate the relevance and performance of the channels of nonverbal information in both gestures (SIGs) and the augmentation of their meaning through the use of visual interfaces (VCAs). The hypothesis states that joining both channels of information will have the best performance. As such, experiments are conducted to answer the following questions:

- What are the visual channels that best represent and facilitate participation and feedback within online learning environments?
- Do the VCAs of SIGs augment and promote better means for understanding the message being conveyed?

Experiment Overview

The experiment involves subjecting participants to watch one of three different types of a class simulation video recording for 13:45 minutes. The videos themselves depict a multi-video conferencing online classroom with a teacher at the top and six students along the bottom. The six students are broken into two groups, those who communicate with gestures and/or graphic interfaces, throughout this section referred to as G1, and those who do not, referred to as G2.

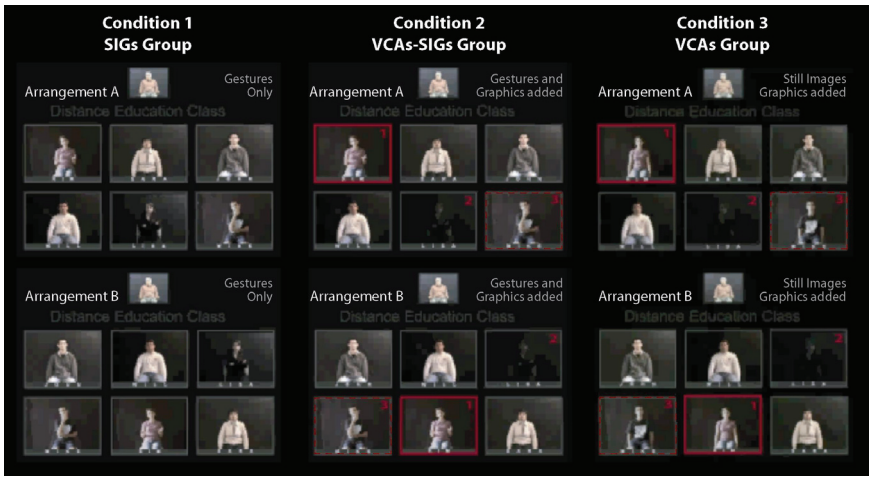


Figure 38: Survey Experimental Demo Conditions

The video is used as the treatment for the experiment. A total of six video recordings are used, which corresponds to the three conditions of the experiment within two arrangements per condition:

- Condition 1—SIGs Performance Group
- Condition 2—VCAs-SIGs Performance Group
- Condition 3—VCAs Performance Group

That is, there are three different videos, in which the first one is a live teleconference, where the actors all move in real-time, three of them using gestures and the rest using no gestures. The second video has the same specifications as the first, but also uses graphic interfaces, such as a red border around an actor, that are activated when the three actors, who use gestures, do so. As such, gestures and/or graphic interfaces appear as they occur in more than one place on the screen at the same time. In the last one, in which none of the actors move, a still image is shown instead, but the graphic interfaces appear, when the actor is gesturing. The goal of having these videos is to test the performance of both visual channels gestural and graphical:

Visual Delivery Channel	**Gestural (SIGs)**	**Non-Gestural**
Graphical (VCAs)	VCAs-SIGs Group *(hypothesis)*	VCAs Group
Non-Graphical	SIGs Group	

Table 5: Visual Delivery Channels

As such, SIGs Group has some actors delivering only gestures; VCAs-SIGs Group has some actors delivering gestures, as well as graphic representations of the gestures' meaning; and VCAs Group has some actors delivering only graphic representations of the gestures' meaning, but gestures are not visible.

After watching the video recording, participants are asked to complete a web survey questionnaire. The survey is used as the observation, to measure the effects of the treatment conditions.

A volunteer sampling comprises the population of participants. Participants were asked randomly to volunteer and take part in the study. The experiments were performed with 90 participants, 31 for the SIGs Group, 30 for the VCAs-SIGs Group and 29 for the VCAs Group.

The web survey questionnaire is divided into different sections completed by participants. Participants can only proceed with the questionnaire after reading the purpose of the study and their involvement, as well as accepting the terms of participating in the experiment (consent). In the first section, participants are asked about demographic information, such as gender, age, etc. In the second section, they are given written instructions to watch the video recording, a Distance Education multi-video conferencing simulation class, on which to base their answers. In the third through the eighth sections, they are asked questions about their perceptions of student participation under different assessments/measures (see Chapter 8 under Measuring Tool Characteristics Section).

Participants are reminded that the survey questions are not based on the topic/content discussed on the video. Rather, they are asked opinions about the class interactions. Also, it is stated to them that there are no right or wrong choices; they are asked simply to do their best in answering each question with their own personal judgment. They are asked to check-off or write their answer in the assigned space below each question.

Within the web survey questionnaire, participants are asked to respond not only to forced choice questions, but open-ended constructed responses that justify their selections. They are asked to write in their own words a brief description of the reasons why they have made such choices. The goal of having open-ended questions is to provide a foundation for the reasoning of the participant towards answering the questions.

The Settings

The majority of the experiments were conducted at the Digital Media Lab located at the DH Hill Library of NCSU. The Lab offers the opportunity for several participants to perform the experiment at the same time.

Figure 39: Survey Delivery Settings

Participants were using headphones, while watching the video recording, so as not to disturb other participants. The computers were placed next to one another. Experimental conditions were assigned randomly to the computers.

The environmental conditions of the setting were constant; a quiet environment, comfortable temperature and soft lighting were among the beneficial properties of conducting the experiments in the lab.

What has been learned from conducting the experiments?

Prior to explaining the results, several considerations should be stated. The researcher observed that the length of the video recording seemed to be too long for the participants to maintain undivided attention. There were a few cases in which the experiments were administered though e-mail to a number of people. In those cases, the researcher did not have control over the outcomes. Therefore, the researcher does not know the engagement level of the participants in those settings.

The majority of the experiments were executed by the researcher, who personally invited and supervised the participants. For those cases, it was found that the majority of the participants seemed unenthusiastic watching the video recording. The researcher's presence helped participants to maintain a level of engagement during the experiment.

Results Analysis

Results analyses are explained by section according to the structure of the web survey questionnaire. Descriptive statistics are explained for section one. There is a brief description about watching the movie; however, no analysis can be performed under section two. Both quantitative and qualitative open-ended questions are included in the third to eighth sections. For the quantitative questions, descriptive statistics are used to explain participation assessment. Then, inferential statistical analyses are explained by answering the five questions of the proposed data analysis (see Chapter 8, Data Analysis). Finally, descriptive statistics of coded data are explained for the qualitative questions in those sections and the last section of the web survey questionnaire.

Section One Web Survey Questionnaire Results

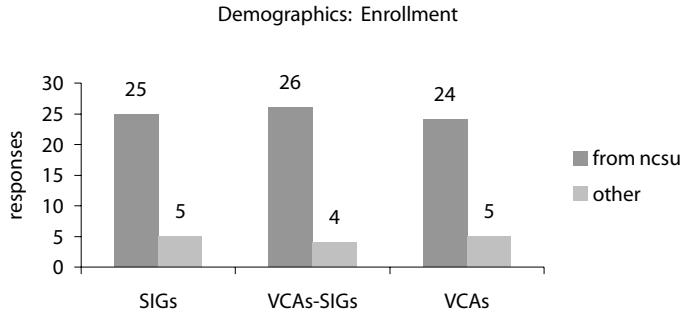
The Survey Demographics

The purpose of having a demographic section in the web survey questionnaire is to monitor the population participating in the experiments. By monitoring the population, the researcher can propose further research, if results seem to be affected by demographic variables.

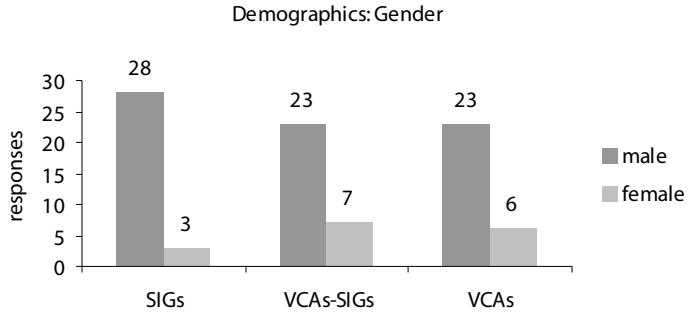
Demographic results are quite similar across the studies. Regardless of the fact that the study used a volunteer sampling, results from the demographic data collection show little variance across the studies. Therefore, results across conditions are comparable without concern of demographic variables affecting the outcome.

From all the studies, results show that 83.3% of the participants were enrolled at the institution—NCSU. The majority of the participants were males (82.2%).

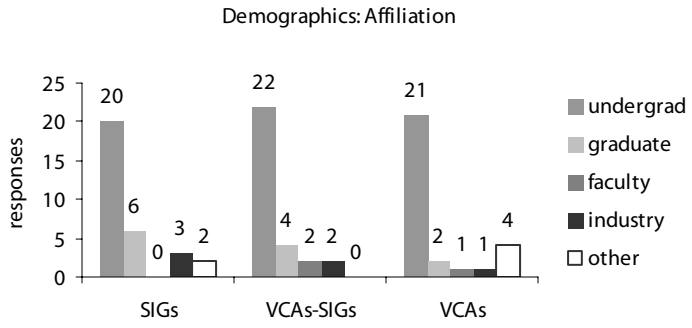
Data shows that the majority were undergraduate students (70%) followed by graduate students (13.3%), between 18 and 24 years old (72.2%). Also, the majority were English-speaking participants (90%). Participants were also asked, if they have ever participated in a videoconferencing or distance learning class. Only 18.9% responded "yes," having participated at least two times or more (58.8%) (see Appendix C for more detailed results for the demographic section of the study).



[7]



[7] Note, "enrollment" was a test question, where one participant fails to answer without compromising the representation in the study.


Demographics: Affiliation
responses
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20
6
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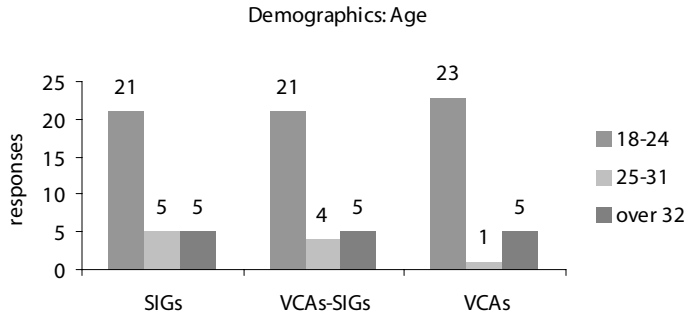
VCAs-SIGs
VCAs
undergrad
graduate
faculty
industry
other


Demographics: Age
responses
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SIGs
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VCAs
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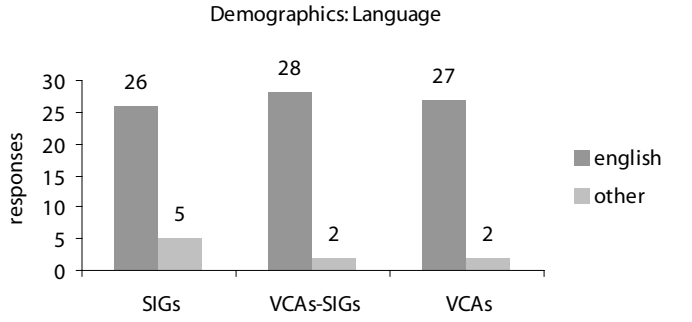
over 32


Demographics: Language
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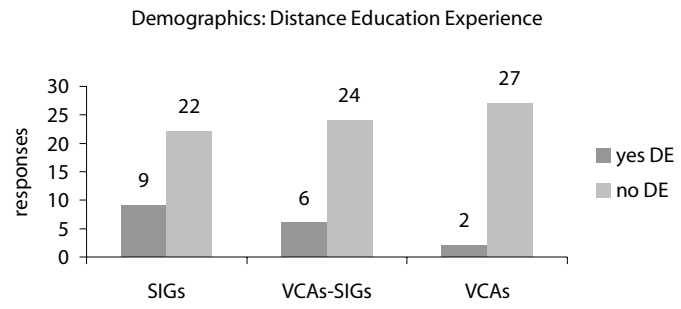
SIGs
VCAs-SIGs
VCAs
english
other



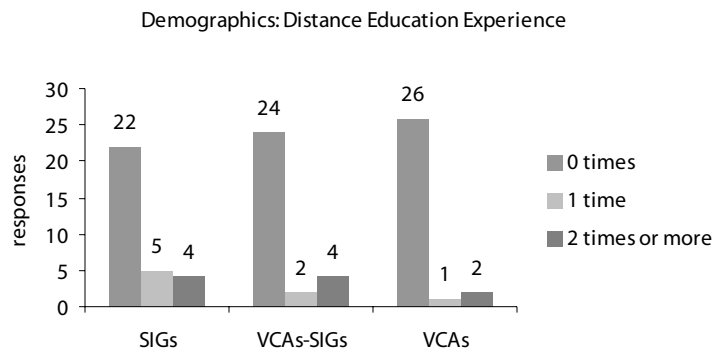


Figure 40: Survey Demographics Graphs

Section Two Web Survey Questionnaire Results

The Video Recording

All participants, who completed the survey, watched the class simulation movie without interruption for 13:45 minutes. An internal clock was developed for the section on the web survey questionnaire to control the time spent watching the movie. Those participants, whose time did not meet the minimum number of seconds expected or needed to complete the section, were excluded from the data analysis. Those excluded participants are not part of the 90 participants previously mentioned as the experimental representative sample.

Section Three of Web Survey Questionnaire
M1: Active Participation Measure

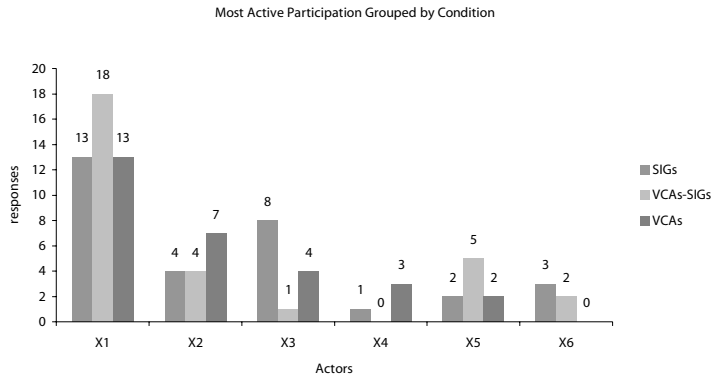
In section three, participants were asked to rank the student actors in the video recording, based on perceived active participation. With six students in the video, respondents gave a rank of one to whom they thought participated most, a rank of two to whom they thought participated second most, etc. Recall that the videos are designed, so that all student actors actually participate the same amount.

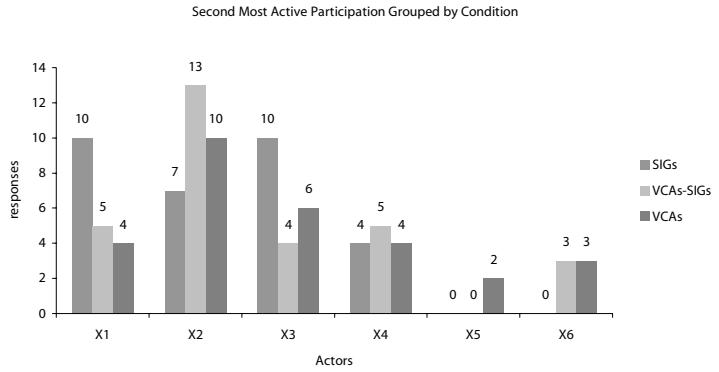
responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs 1 - 31	1	2	3	4	5	6
VCAs-SIGs 1 - 30	1	2	3	4	5	6
VCAs 1 - 29	1	2	3	4	5	6

Figure 41: Active Participation Analysis

Descriptive and Qualitative Analysis

It was expected that student actors: who gestured and/or used graphic interfaces in the video simulation class (G1), would have the highest ratings; where the active participation gesturer (student actor X1) would have the highest rating (1), the uncertain/thinking gesturer (student actor X2) would have the second to highest rating (2); the avoiding attention gesturer (student actor X3) would have the third to highest rating (3); and the rest of the student actors, who did not gesture and/or had graphic interfaces would have the lowest ratings.





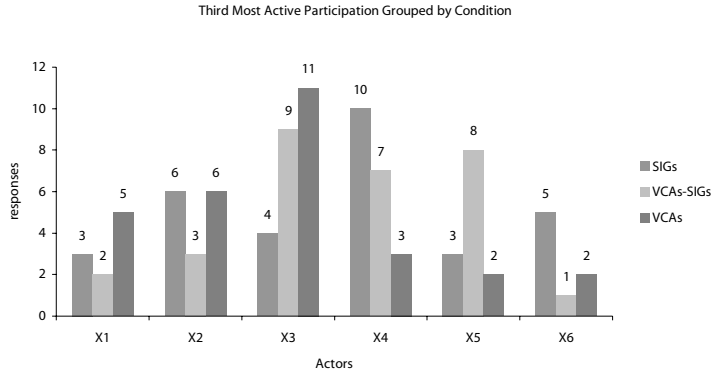


Figure 42: Active Participation Scales Grouped by Condition Graphs

In the above graphs, the different bars represent the different video types/conditions, with the six participants broken into two groups. The first group (G1) is of main interest. Each actor in G1 performs a different hand gesture during the live video. The actors in G1 are also the only ones provided with the graphic interfaces in the VCAs-SIGs Group and VCAs Group. X1 rolls her hands and/or activates a red frame to demonstrate active participation; X2 makes a hand on chin/cheek gesture and/or activates a dotted red frame to demonstrate uncertainty and thinking, while X3 crosses her arms and/or activates half opacity window to demonstrate avoiding attention; and X1, X2 and X3 raise their hands and/or activate a red orderly number to demonstrate call for attention and positive feedback.

Results visually confirm the expectations of the study on perceived participation, with X1 (roll hands/red frame) being the most, followed by X2 (hand on chin-cheek/dotted red frame) and X3 (cross arms/half opacity window). If looked at closely, X1 and X2 perform better in VCAs-SIGs Group, which is the hypothesis, but this does not hold true with X3.

Following the ranking question, participants were asked to briefly describe the reason why they made their assessment(s). First, they were asked to write about how they selected the student, who participated the most; and second, how they selected the student, who participated the least. Asking those questions helps to validate their responses.

All responses were coded into four different categories:

- If the response was based on gestural/graphical assessment
- If the response was based on a both gestural/graphical and verbal assessment
- If the response was based on verbal assessment
- If the response was neutral or no opinion offered

Participant's responses were coded from the rationale explained earlier, which is followed throughout the following sections. The coded participant responses confirm that 64% of the participants based their answers on the

verbal channel across conditions, in which 58% responded for SIGs Group, 60% for the VCAs-SIGs Group, and 76% for the VCAs Group.

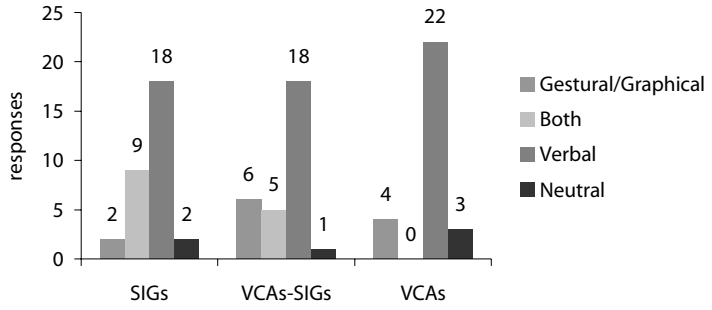


Figure 43: Description Most Participation Assessment Graph

Participants made comments such as:

> *"She seemed to talk more than the other students and body language showed interest" (SIGs Group)*
>
> *"The student was willing to speak on more number of questions that were asked to everyone (by raising her hand) and responding to them" (SIGs Group)*
>
> *"I recall her raising her hand the most" (VCAs-SIGs Group)*

Many of the comments show that gestures affect the understanding of participation. However, the majority assessed the most participation in terms of using the verbal channel (such as the length and times that actors participated). One possible explanation of the small percentage could be that gestures in this type of online learning environments are lost and not easily readable. As such, the absence of such mechanisms forces the participants to rely more on the verbal, than the visual channel. From the following quote, it is apparent that there is a need for mechanisms to augment the understanding of interaction.

"It was very hard to tell which student participated the most since it was not made clear who was speaking at the time..." (VCAs-SIGs Group)

"I could not tell which male was speaking, when they answered questions, but since Mike's box was outlined in red - I assumed that he was speaking each time a male voice was made audible" (VCAs-SIGs Group)

When participants were asked about their assessment towards the selection of the actor, who participated the least, 70% of the population from all conditions responded based on the verbal channel, in which 71% responded for SIGs Group, 60% for VCAs-SIGs Group, and 79% for VCAs Group.

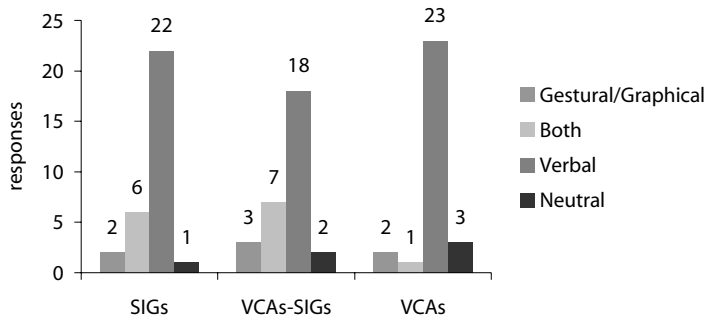


Figure 44: Description Least Participation Assessment Graph

As can be seen, VCAs-SIGs Group has slightly lower responses than the other conditions. Although the outcome is based on the verbal channel, important comments were made, based on the role of movement and graphic interfaces as a participatory measure, in this case for least participation:

"John sat in the same position for most of the class… He moved very little and didn't speak too often" (SIGs Group)

"I believe that Lisa participated the least based on her posture and keeping her arms crossed along with the answers to the questions" (SIGs Group)

"This was a dark window frame and only seemed to light up a few times, when Lisa spoke" (VCAs-SIGs Group)

"I don't recall him speaking other than at the very beginning, when he introduced himself... Other times the video did not tell you who was speaking, so it could have been him" (VCAs Group)

Statistical Analysis

Even though the ranking results were visually positive, the purpose of the study is to know, if they are statistically significant. As such, five main questions are answered, where different statistical methods are used.

In general, the research experiment aims to first show that there is a significant difference in ranked Active Participation among those student actors, who gesture (G1) and those who do not (G2). Second, the researcher wants to prove that there are differences among all conditions. Third, is to test if there is difference in G1on a specific student actor gesturer from others. Fourth, is to test if there is a difference of G1 across conditions. And lastly, the research experiment aims to show if there is a difference of the gesture of the participatory measure under study on the condition that uses both channels of nonverbal information: gestural (SIGs) and graphical (VCA) in order to test the hypothesis. All analysis is based on answering the five different questions that have been earlier proposed in the data analysis section (see Chapter 7 Data Analysis). For readability, the researcher uses the questions for structuring the results for each section of the web survey questionnaire.

Question One
Is there a difference between G1 and G2 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

SAS is used to show that there is a difference between rankings of those in the G1 (student actors who use SIGs and/or VCAs) and G2 (student actors who do not use SIGs or VCAs). For each person surveyed, an average rank is calculated

of how participants assessed participation among the actors of G1 and another average rank for those in the G2 of the video recording. After defining a variable of the difference in these two averages, the difference is modeled in Proc GLM with predictor of conditions (video types). The following is obtained:

Dependent Variable: AP Difference of G1and G2

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Intercept	1	195.5604938	195.5604938	92.87	<.0001
Treatment	2	4.5714388	2.2857194	1.09	0.3423

Parameter	Estimate	Standard Error	T Value	Pr > |t|
Intercept	1.155555556 B	0.26493793	4.36	<.0001
SIGs	0.468100358 B	0.37164493	1.26	0.2112
VCAs-SIGs	0.488122605 B	0.37789500	1.29	0.1999
VCAs	0.000000000 B	.	.	.

Table 6: Active Participation Group Difference Analysis

From the output, with a significant non-zero intercept, it can be said that there are in fact higher average ranks for the actors, who make hand gestures and/or use graphic interfaces versus those who do not. Therefore, it can be said that, from all the studies, participants perceive more participation from actors, who gesture and/or use graphic interfaces than actors, who do not gesture and/or do not use graphic interfaces. More statistical analyses are performed to test, if there is a difference between G1 and G2 (Y) within the active participation measure. A t-statistic test is performed. Define a variable Y=(X1+X2+X3)/3-(X4+X5+X6)/3. If the mean of Y is not 0, then we may say that there is a difference between G1 and G2. For Y,

Mean -1.47407 Std Deviation 1.45252

Tests for Location: μ_0=0

Test	Statistic	p Value
Student's t	t -9.62763	Pr > |t| <.0001

Table 7: Active Participation Group Difference Analysis

Since the p-value is less than 0.0001, again, there is strong evidence that there is a difference between G1 and G2. As such, it can be said that student actors, who use gestures and/or graphic interfaces (G1) are perceived differently than the student actors, who do not use either (G2).

Question Two
Is there a difference among conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Now, there is a need to understand, if there is a difference of active participation among all conditions. A one-way Analysis of Variance (ANOVA) is performed to test the difference.

Dependent Variable: AP Difference Among Conditions

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4.5714388	2.2857194	1.09	0.3423
Error	87	183.2014007	2.1057632		
Corrected Total	89	187.7728395			

R-Square	Co-eff Var	Root MSE	Mean
0.024346	-98.44314	1.451125	-1.474074

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	4.57143877	2.28571939	1.09	0.3423
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	4.57143877	2.28571939	1.09	0.3423

Table 8: Active Participation Conditions Difference Analysis

Since the p-value is 0.3423>0.05, there is no difference among the three conditions. However, to address this issue the averaged ranks as calculated for G1 can be tested. In Proc GLM, this average rank is modeled with a predictor of each condition to get the following:

Dependent Variable: Averaged Rank Among Conditions

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Intercept	1	687.0567901	687.0567901	1305.10	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	1.1428597	0.5714298	1.09	0.3423

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
diff VCAs SIGs	1	0.00150167	0.00150167	0.00	0.9575
diff VCAs-SIGs VCAs	1	0.87834491	0.87834491	1.67	0.1999
diff VCAs-SIGs SIGs	1	0.83516266	0.83516266	1.59	0.2112

Parameter	Estimate	Standard Error	T Value	Pr > |t|
Intercept	2.922222222 B	0.13246897	22.06	<.0001
SIGs	-0.234050179 B	0.18582246	-1.26	0.2112
VCAs-SIGs	-0.244061303 B	0.18894750	-1.29	0.1999
VCAs	0.000000000 B	.	.	.

Table 9: Active Participation Ranking Among Conditions Analysis

Contrasts were made to test, if there are differences in these average rankings among the conditions. As none of these contrasts are significant, it can be said that as a whole the ranks do not differ on average across the three conditions.

Question Three

Is there a difference among the three students of G1 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Now we need to focus on the rankings of just those, who had gestures and/or graphic interfaces. After calculating the average rank of X1, X2, and X3 of 2.2111, 2.8889, and 3.1889 respectively.

Dependent Variable: AP Difference of X at G1

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	45.1629630	22.5814815	9.64	<.0001
Error	267	625.6666667	2.3433208		
Corrected Total	269	670.8296296			

R-Square	Co-eff Var	Root MSE	Mean
0.067324	55.40396	1.530791	2.762963

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Difference	2	45.16296296	22.58148148	9.64	<.0001
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Difference	2	45.16296296	22.58148148	9.64	<.0001

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
X1AP vs X2AP	1	20.67222222	20.67222222	8.82	0.0032
X2AP vs X3AP	1	4.05000000	4.05000000	1.73	0.1898
X1AP vs X3AP	1	43.02222222	43.02222222	18.36	<.0001

Table 10: Active Participation Difference of X at G1 Analysis

There is strong evidence that there is difference among X1-X3 over the conditions. Now, we are also interested in difference between two of the students of X1-X3. By the results above, we may say that there is a difference between X1 and X2, and X1 and X3 because the p-values are 0.0032 and less than 0.0001, respectively. Thus, the rank of X1 is the lowest among the ranks of the three students. The next step is to perform t-tests to see, if this average rank is significantly higher in one gesture/graphic versus another. Under the significance level α=.05, it can be concluded that the average ranks of X2 and X3 are significantly higher than X1. The t-test to show that the average rank of X3 is higher than X2 has a p-value of about .09. As such, if an α=.10 is taken, a claim of significance can be made. In other words, the difference of X1, X2, and X3 is statistically significant at α=0.10.

The overall idea here is that on average X1 was perceived to be the most active of the hand signal participants, while X3 was perceived to be the least active of G1. Now, there is a need to show that these ranks are different across the different conditions.

Question Four
Is there a difference among the conditions of G1?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Now that it is known that there is no general difference in average ranks across conditions (question 2), analysis can be performed only at G1 to see, if overall a particular actor performing hand gestures was viewed differently depending on which video type a participant watched. From SAS, we model each of X1, X2, and X3 rankings with predictor video type or condition. Using the same contrasts, as above, we have the following set of outputs:

Dependent Variable: X1 Rank Participation at G1among conditions

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
diff VCAs SIGs	1	0.52949574	0.52949574	0.21	0.6517
diff VCAs-SIGs VCAs	1	2.52483928	2.52483928	0.98	0.3253
diff VCAs-SIGs SIGs	1	0.77736647	0.77736647	0.30	0.5845

Dependent Variable: X2 Rank Participation at G1 among conditions

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
diff VCAs SIGs	1	7.47543567	7.47543567	3.59	0.0615
diff VCAs-SIGs VCAs	1	1.16939412	1.16939412	0.56	0.4558
diff VCAs-SIGs SIGs	1	2.75030848	2.75030848	1.32	0.2537

Dependent Variable: X3 Rank Participation at G1 among conditions

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
diff VCAs SIGs	1	3.57287727	3.57287727	1.71	0.1938
diff VCAs-SIGs VCAs	1	11.01702708	11.01702708	5.29	0.0239
diff VCAs-SIGs SIGs	1	27.89642165	27.89642165	13.39	0.0004

Table 11: Contrasts of X at G1 Among Condition Analysis

The main interest in this area is to show that the video with hand gestures and graphic interfaces (VCA-SIGS) yields different rankings of the G1 actors group. Results indicate that the participatory measure *active participation* does not differ among conditions and actors. However, it can be said that this only holds true for X3, which was the participant, who crossed the arms during the class simulation.

From the same output, we see that this gesture gets a higher ranking on the VCAs-SIGs condition than the other two. This test supports the hypothesis, where the VCAs-SIGs group performs better in augmenting the meaning of the message, in that crossing of arms is perceived to be a negative type of hand gesture. As is shown, joining both channels of information, both gestural and graphical, facilitates communication within the active participation measure. From the data we see this difference in rankings is most prominent in the VCAs-SIGS video group.

Dependent Variable: X Difference at G1 Among Condition

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1.14285969	0.57142985	1.09	0.3423
Error	87	45.80035018	0.52644081		
Corrected Total	89	46.94320988			

R-Square	Co-eff Var	Root MSE	Mean
0.024346	26.26030	0.725562	2.762963

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	1.14285969	0.57142985	1.09	0.3423
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	1.14285969	0.57142985	1.09	0.3423

Table 12: Difference of X at G1 Among Conditions Analysis

Results indicate that there is no difference among conditions, because the p-value is 0.3423>0.05. As such, it can be said that the amount of nonverbal information channels does not make a difference in perceived participation within the active participation measure.

Question Five
Is X1 associated with the hypothesis?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

This question refers to whether the measure of active participation (X1) is associated with the conditions. The test of independence is considered, that is, the chi-square test.

From the chi-square test, with statistic=8.0251 and p-value=0.6264>0.05, it can be said that there is no association between conditions and responses of X1. As such, this result does not hold true of the hypothesis.

Section Four Web Survey Questionnaire Results
M2: Call for Attention Measure

In section four, participants were asked to assess, who and how from the six student actors called for attention in the video recording. They were also asked to write in their own words - why they made a particular selection. Finally, they were asked to select the mechanism they would choose to call for attention, if participating in the same online learning environment.

Descriptive and Qualitative Analysis

Results show that 80%, the majority of the participants, chose the student actors, using both verbal and gestural/graphical channels for calling for attention, in which 83% responded in SIGs Group, 90% in VCAs-SIGs Group, and 65% in VCAs Group. That is, the majority of the participants would raise their hands or just talk to call for attention.

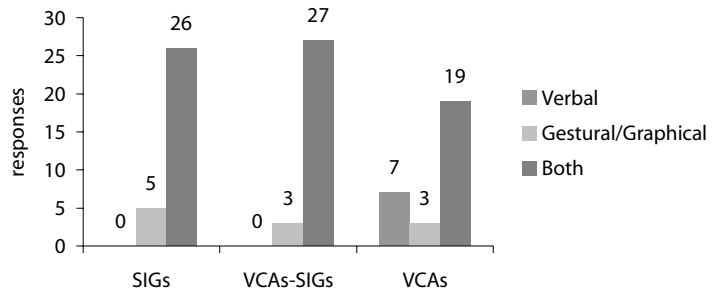


Figure 45: Call for Attention Assessment Graph

However, when participants were asked how they made the assessment, the majority answered in terms of using the gestural/graphical channel (86%), with 71% of the responses in SIGs Group, and 93% in both VCAs-SIGs Group and VCAs Group. As such, it can be said that SIGs and VCAs are a powerful source of communication, when linked to the calling for attention participatory measure.

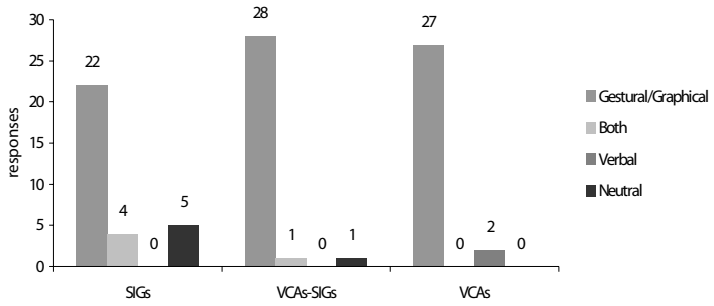


Figure 46: Call for Attention Qualitative Assessment Graph

Descriptions are based on coding their answer towards how they made the selection of who called for attention, during the simulation class video recording. Below are a few meaningful answers from the participants:

"The movement of the arm drew my attention to the students" (SIGs Group)

"They raised their hands... Those who didn't took me a second to realize who was talking" (SIGs Group)

"They offered more motion - more visual contrast against the black background… The ones who just started talking were hard to identify initially, because there was no visual movement on their part and their mouth movements weren't enough to see" (VCAs-SIGs Group)

"The students, who raised their hands, often were not the first to talk, but eventually voiced their opinion… It was hard to find the person who was talking, if they did not raise their hand. Therefore, it is important to call the professor's attention by raising your hand" (VCAs-SIGs Group)

"I recognized these students as their pictures highlighted, when they were willing to answer a question and also the numbers appeared that showed me the order in which they will respond to the question" (VCAs Group)

"The students that I checked had some way of indicating that they were speaking, which made it much easier to learn their voices (which provided more cues)" (VCAs Group)

When participants were asked to select the interaction mechanism they would use in this type of environment, 68% of the participants in SIGs Group and 63% of the participants in VCAs-SIGs Group would call for attention using gestures and/or graphical interfaces; while the majority of the VCAs Group participants (55%) would use both verbal and graphical mechanisms.

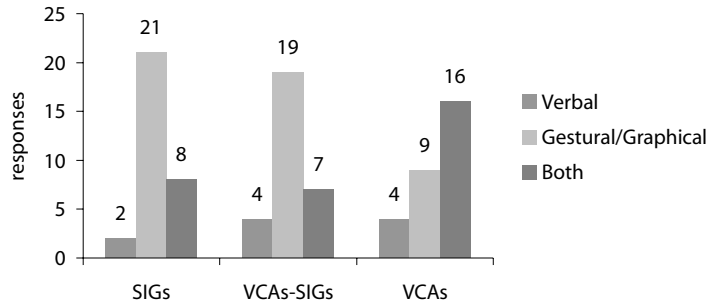


Figure 47: Call for Attention Interaction Choice Graph

Statistical Analysis

With six students in the video, respondents were to place a checkmark next to the students they thought called for attention. They could check as many as applied. It is expected that students who gestured raising their hands (X1, X2 and X3) in the video simulation class have the highest ratings.

Question One

Is there a difference between G1 and G2 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

The T test statistical analysis is performed to test the difference of call for attention between groups (Y). Define a variable Y=(X1+X2+X3)/3-(X4+X5+X6)/3. If the mean of Y is not 0, then we may say that there is difference between G1 and G2. For Y,

Mean	0.766667	Std Deviation	0.31780
Test		Statistic	p Value
Student's t		t 22.886	Pr > |t| <.0001

Table 13: Call for Attention Group Difference Analysis

There is strong evidence that there is difference between G1 and G2, because the p-value is less than 0.0001. As such, it can be said that student actors, who use gestures and/or graphic interfaces (G1) are perceived differently than the student actors, who do not (G2) within the call for attention participatory measure.

Question Two
Is there a difference among conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

A one-way ANOVA is performed to test the difference of call for attention among conditions.

Dependent Variable: CA Difference Among Conditions

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.34588638	0.17294319	1.74	0.1814
Error	87	8.64300251	0.09934486		
Corrected Total	89	8.98888889			

R-Square	Co-eff Var	Root MSE	Mean
0.038479	41.11176	0.315190	0.766667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	0.34588638	0.17294319	1.74	0.1814
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	0.34588638	0.17294319	1.74	0.1814

Table 14: Call for Attention Conditions Difference Analysis

There is no difference among conditions, because the p-value is 0.1814>0.05. As such, the amount of nonverbal information delivery channels does not have a difference in perceived participation within the call for attention measure.

Question Three

Is there a difference among the three students of G1 over all conditions?

Three sets are considered in the analysis of the difference of X at G1 within the call for attention measure: (X1*X2, X2*X3, X1*X3). The "McNemar's Test" is used for dependent proportions of each set, because of the dichotomous nature of the response (0/1).

For X1 and X2, Statistic=1.3333 with p-value=0.2482.
For X1 and X3, Statistic=7.1176 with p-value=0.0076.
For X2 and X3, Statistic=3.2667 with p-value=0.0707.

At the level of significance α=0.05, there is only a difference between X1 and X3. However, at the level of significance of 0.1, there is a difference between X3 and X1, and X3 and X2. That is, participants are able to better differentiate the meaning and performance of the call for attention participatory measure regardless of the difference, since all G1 student actors perform the same gesture.

Question Four

Is there a difference among the conditions of G1?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

A one-way ANOVA is performed to test the difference of call for attention at G1 among conditions.

Dependent Variable: CA Difference at G1 Among Conditions

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1.17769126	0.58884563	10.13	0.0001
Error	87	5.05564207	0.05811083		
Corrected Total	89	6.23333333			

R-Square	Co-eff Var	Root MSE	Mean
0.188934	28.17606	0.241062	0.855556

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	1.17769126	0.58884563	10.13	0.0001
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	1.17769126	0.58884563	10.13	0.0001

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
diff VCAs-SIGs SIGs	1	0.90546904	0.90546904	15.58	0.0002
diff VCAs-SIGs VCAs	1	0.87558932	0.87558932	15.07	0.0002
diff VCAs SIGs	1	0.00007051	0.00007051	0.00	0.9723

Table 15: Call for Attention Difference at G1 Among Conditions Analysis

Results show that there is difference among conditions. From the results, VCAs-SIGs is different from VCAs and SIGs; and there is no difference between VCAs and SIGs. As such, it can be said that joining channels of nonverbal information, both gestural and graphical, does create a difference in perceived participation within the call for attention measure.

Section Five Web Survey Questionnaire Results

M3: Avoid Attention Measure

In section five, participants were asked to assess, who and how from the six student actors avoided attention in the video recording. They were also asked to write in their own words why they made a particular selection. Finally, they were asked to select the mechanism they would choose to avoid attention, if participating in the same online learning environment.

Descriptive and Qualitative Analysis

Results show that 62%, the majority of the participants, chose the student actors, using only a verbal channel for avoiding attention across the studies, with 58% of responses in SIGs Group, 57% of responses in VCAs-SIGs Group, and 72% of responses in VCAs Group. That is, the majority of the participants would just not talk to avoid attention.

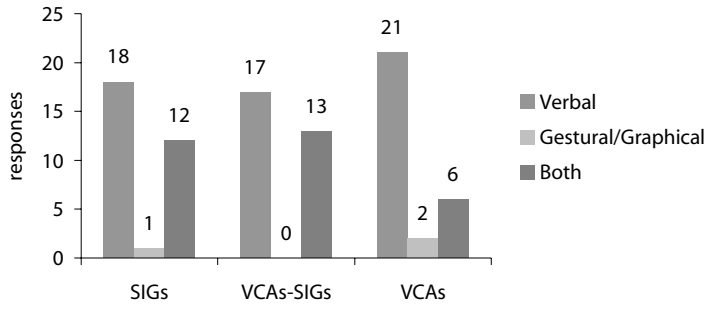


Figure 48: Avoid Attention Assessment Graph

However, when participants were asked how they made the assessment, most of the participants answered in terms of using the gestural/graphical channel (70%), with 87% of the responses in SIGs Group, 77% in VCAs-SIGs Group, and 45% in VCAs Group. As such, it can be said that SIGs and VCAs are a powerful source of communication, when linked to the avoid attention participatory measure.

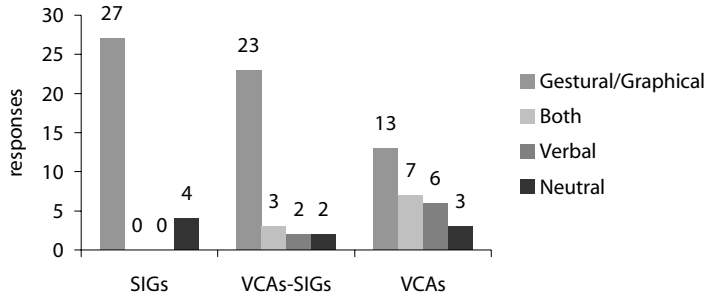


Figure 49: Avoid Attention Qualitative Assessment Graph

Descriptions are based on coding their answer towards how they made the selection of who avoided attention, during the simulation class video recording. A number of participants had difficulty in understanding the SIGs and VCAs of avoiding attention. Also, it was found that some participants considered the "non animated' actors sitting on their hands as a gesture

representing uninterested. In general, participants wrote meaningful answers, as follows:

> *"I recognized this student by her crossing her hands during the class, when she was not speaking" (SIGs Group)*
>
> *"When not speaking Lisa's hands were crossed… She seemed to spring to life when she had something to say" (VCAs-SIGs Group)*
>
> *"Her screen or display was darker than all of the others" (VCAs Group)*

What is interesting is that when participants were asked to select the interaction mechanism, they would use in this type of environment, the majority of the population from all conditions significantly answered they would use the verbal channel (i.e. just not talking): 87% of the responses in SIGs Group, 87% of the responses in VCAs-SIGs Group, and 76% of the responses in VCAs Group.

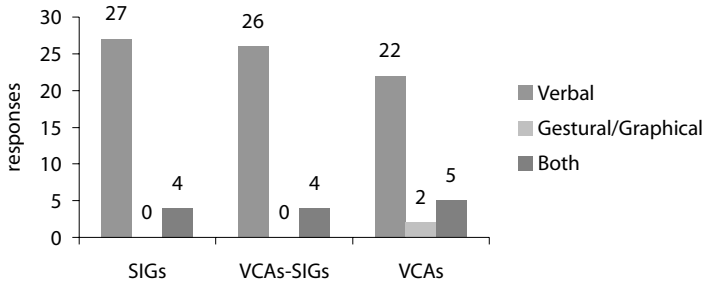


Figure 50: Avoid Attention Interaction Choice Graph

Statistical Analysis

With six students in the video, respondents were supposed to place a checkmark by the student, who they thought avoided attention the most. They could checkmark as many as applied. It is expected that the student,

who gestures by crossing arms (X3) in the video simulation class has the highest ratings.

Question One
Is there a difference between G1 and G2 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

The T test statistical analysis is performed to test the difference of avoid attention between groups (Y) . Define a variable Y=(X1+X2+X3)/3-(X4+X5+X6)/3. If the mean of Y is not 0, then we may say that there is a difference between G1 and G2.

Mean	0.107407	Std Deviation	0.45750

Test	Statistic	p Value
Student's t	t 2.227218	Pr > |t| 0.0285

Table 16: Avoid Attention Group Difference Analysis

Since the p-value is 0.0285<0.05, results indicate that there is a difference between G1 and G2. As such, it can be said that students, who use gestures and/or graphic interfaces (G1) are perceived differently than the student actors, who do not (G2) within the avoid attention participatory measure.

Question Two
Is there a difference among conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

A one-way ANOVA is performed to test the difference of avoid attention among conditions.

Dependent Variable: AA Difference Among Conditions

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	2.82321647	1.41160823	7.77	0.0008
Error	87	15.80517859	0.18166872		
Corrected Total	89	18.62839506			

R-Square	Co-eff Var	Root MSE	Mean
0.151554	396.8312	0.426226	0.107407

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	2.82321647	1.41160823	7.77	0.0008

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	2.82321647	1.41160823	7.77	0.0008

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
Diff SIGs VCAs-SIGs	1	2.10963622	2.10963622	11.61	0.0010
Diff VCAs-SIGs VCAs	1	2.16031560	2.16031560	11.89	0.0009
Diff SIGs VCAs	1	0.00086374	0.00086374	0.00	0.9452

Table 17: Avoid Attention Condition Difference Analysis

For effect of conditions, p-value=0.0008. Thus, we may say that there is a difference among the conditions. Since, there is a difference among the conditions, there is a need to know where the difference lies:

VCAs-SIGs Group has a difference with SIGs Group and VCAs Group, and there is no difference between SIGs Group and VCAs Group. In other words, it can be said that having a single channel of nonverbal information does not make a difference. Whereas, having both channels of information (VCAs-SIGs Group) within the avoid attention participatory measure is statistically different among other conditions having a single channel of nonverbal information.

Question Three

Is there a difference among the three students of G1 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Three sets are considered in the analysis of the difference of X at G1 within the avoid attention measure: (X1*X2, X2*X3, X1*X3). The "McNemar's Test" is used for dependent proportions of each set, because of the dichotomous nature of the response (0/1).

For X1 and X2, Statistic=6.3684 with p-value=0.0116.
For X1 and X3, Statistic=42.0870 with p-value<0.0001.
For X2 and X3, Statistic=23.1702 with p-value<0.0001.

At the level of significance α=0.05, there is a difference among the student actors (G1), in which X3 has a difference with X1 and X2, and there is also a difference between X1 and X2. That is, participants are able to better differentiate the meaning and performance of the avoid attention participatory measure among the others.

Question Four

Is there a difference among the conditions of G1?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

A one-way ANOVA is performed to test the difference of avoid attention at G1 among conditions.

Dependent Variable: AA at G1 Among Conditions

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.51246378	0.25623189	3.93	0.0232
Error	87	5.67148684	0.06518950		
Corrected Total	89	6.18395062			

R-Square	Co-eff Var	Root MSE	Mean
0.082870	87.26207	0.255322	0.292593

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	0.51246378	0.25623189	3.93	0.0232
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	0.51246378	0.25623189	3.93	0.0232

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
Diff SIGs VCAs-SIGs	1	0.43777242	0.43777242	6.72	0.0112
Diff VCAs-SIGs VCAs	1	0.32924216	0.32924216	5.05	0.0271
Diff SIGs VCAs	1	0.00705094	0.00705094	0.11	0.7430

Table 18: Avoid Attention Difference at G1Among Conditions Analysis

There is a difference among the conditions with p-value=0.0232<0.05. As such, there is a need to know, where the difference lies:

VCAs-SIGs Group has a difference with SIGs Group and VCAs Group. However, there is no difference between SIGs Group and VCAs Group. Again, it can be said that joining channels of nonverbal information, both gestural and graphical, does create a difference in perceived participation within the avoid attention measure.

Question Five
Is X3 associated with the hypothesis?

	G1			G2		
responses	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

This question is asking whether the avoid attention measure (X3) is associated with conditions. The test of independence is considered, that is, the chi-square test. For X3, the statistic of the chi-square test is 10.0036 with p-value=0.0067. Therefore, there is evidence that the responses of X3 are different among conditions. This result does hold true of the hypothesis.

Section Six Web Survey Questionnaire Results
M4: Uncertainty/Thinking Measure

In section six, participants were asked to assess, who and how from the six student actors demonstrates uncertainty or thinking in the video recording. They were also asked to write in their own words why they made a particular selection. Finally, they were asked to select the mechanism they would choose for demonstrating uncertainty/thinking, if participating in the same online learning environment.

Descriptive and Qualitative Analysis

Results show that 54%, the majority of the participants, chose the student actors using only a verbal channel across the studies for demonstrating uncertainty or thinking, in which 48% responded in SIGs Group, 47% in VCAs-SIGs Group, and 69% in VCAs Group. That is, the majority of the participants would just talk to demonstrate they don't understand the subject matter.

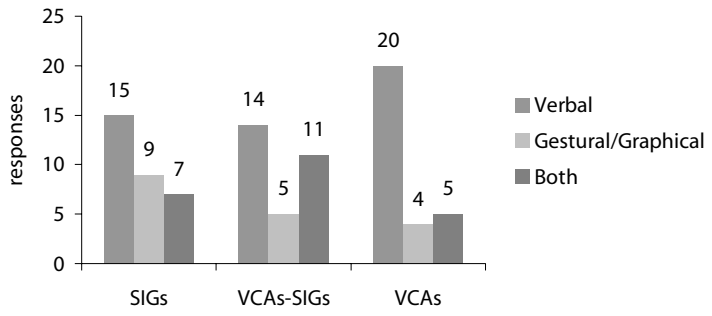


Figure 51: Uncertainty/Thinking Assessment Graph

However, when participants were asked how they made the assessment, most of the participants answered in terms of using the gestural/graphical channel, except VCAs Group in which there is a tie between the verbal channel (34%) and not having an opinion on the question (34%). Results indicate 77% of responses in SIGs Group and 87% in VCAs-SIGs Group. As such, it can be said that SIGs and VCAs are a powerful source of

communication, when linked to the uncertainty/thinking participatory measure.

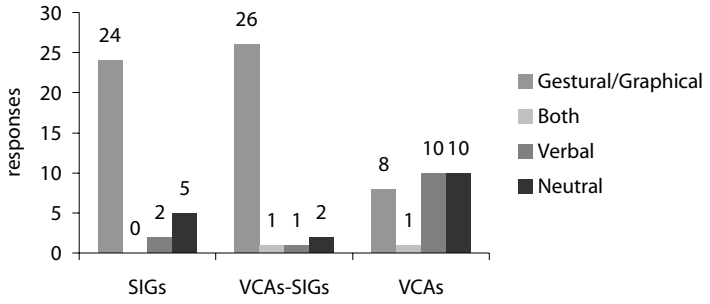


Figure 52: Uncertainty/Thinking Qualitative Assessment Graph

Descriptions are based on coding their answer towards how they made the selection of who demonstrated uncertainty or thinking during the simulation class video recording. In general, the visual cue (dotted red frame) was not considered, when writing the statements. A number of participants did not understand the meaning of this visual cue. Moreover, some participants answered the question that they did not understand the meaning of uncertainty. However, overall it is apparent that the gesture of hand in chin is powerful in demonstrating uncertainty and thinking, as participants wrote meaningful statements, as follows:

> *"I recognized him because he placed his hand on his chin, when he wasn't talking, which leads me to believe that he was confused or in deep thought about what was being said" (SIGs Group)*

> *"Mike's constant movements and mannerisms showed that he was much more involved in the conversation by placing his hand on his chin repeatedly showed to me that he was more cognitive then the others" (SIGs Group)*

"The red box and constant movement drew my attention to Mike; that combined with the fact of possible still frames" (VCAs-SIGs Group)

"The student put a dashed line around their image" (VCAs Group)

When participants were asked to select the interaction mechanism they would use in this type of environment, the majority from all conditions answered that they would use the verbal channel (i.e. just saying "I don't understand"), in which 55% of the responses in SIGs Group, 80% of the responses in VCAs-SIGs Group, and 59% of the responses in VCAs Group.

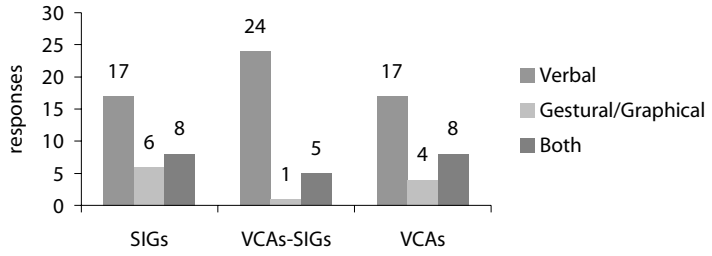


Figure 53: Uncertainty/Thinking Interaction Choice Graph

Statistical Analysis

With six students in the video, respondents were supposed to place a checkmark next to whom they thought demonstrates uncertainty/thinking. They could checkmark as many as applied. It is expected that the student, who gestures hand on chin/cheek (X2) in the video simulation class has the highest ratings.

Question One

Is there a difference between G1 and G2 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

The T test statistical analysis is performed to test the difference of uncertainty/thinking between groups (Y). Define a variable Y=(X1+X2+X3)/3-(X4+X5+X6)/3. If the mean of Y is not 0, then we may say that there is a difference between G1 and G2.

Mean	0.144444	Std Deviation	0.30415

Test	Statistic	p Value	
Student's t	t 4.505357	Pr > |t|	<.0001

Table 19: Uncertainty/Thinking Group Difference Analysis

Results indicate that there is a difference between G1 and G2 with p-value<0.0001. As such, it can be said that students, who use gestures and/or graphic interfaces (G1) are perceived differently, than the student actors who do not (G2) within the uncertainty/thinking participatory measure.

Question Two

Is there a difference among conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

A one-way ANOVA is performed to test the difference of uncertainty/thinking among conditions.

Dependent Variable: UT Difference Among Conditions

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	2.39120834	1.19560417	17.80	<.0001
Error	87	5.84212499	0.06715086		
Corrected Total	89	8.23333333			

R-Square	Co-eff Var	Root MSE	y Mean
0.290430	179.4010	0.259135	0.144444

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	2.39120834	1.19560417	17.80	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	2.39120834	1.19560417	17.80	<.0001

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
Diff SIGs VCAs-SIGs	1	1.83565278	1.83565278	27.34	<.0001
Diff VCAs-SIGs VCAs	1	1.78074117	1.78074117	26.52	<.0001
Diff SIGs VCAs	1	0.00009597	0.00009597	0.00	0.9699

Table 20: Uncertainty/Thinking Condition Difference Analysis

Since the p-value is less than 0.0001, there is difference among the conditions. Since there is a difference among the conditions, there is a need to know where the difference lies. VCAs-SIGs Group has a difference with SIGS Group and VCAs Group. But, there is no difference between SIGs Group and VCAs Group. It can be said that having a single channel of visual information does not make a difference. Whereas, having both channels of nonverbal information (VCAs-SIGs Group) within the uncertainty/thinking participatory measure is statistically different among other conditions having a single channel of nonverbal information.

Question Three

Is there a difference among the three students of G1 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Three sets are considered in the analysis of the difference of X at G1 within the uncertainty/thinking measure: (X1*X2, X2*X3, X1*X3). The "McNemar's Test" is used for dependent proportions of each set, because of the dichotomous nature of the response (0/1).

For X1 and X2, Statistic=48.6000 with p-value<0.0001.
For X1 and X3, Statistic=0 with p-value=1.
For X2 and X3, Statistic=48.6000 with p-value<0.0001.

At the level of significance α=0.05, there is a difference among the student actors (G1), in which there is a difference between X2 and X1, and X2 and X3, but not in X1 and X3. That is, participants are able to better differentiate the meaning and performance of the uncertainty/thinking participatory measure among the others.

Question Four

Is there a difference among the conditions of G1?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

A one-way ANOVA is performed to test the difference of uncertainty/thinking at G1 among conditions.

Dependent Variable: UT Difference at G1 Among Conditions

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.72408437	0.36204219	22.89	<.0001
Error	87	1.37591563	0.01581512		
Corrected Total	89	2.10000000			

R-Square	Co-eff Var	Root MSE	Mean
0.344802	53.89637	0.125758	0.233333

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	0.72408437	.36204219	022.89	<.0001
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	0.72408437	0.36204219	22.89	<.0001

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
diff VCAs-SIGs SIGs	1	0.58519548	0.58519548	37.00	<.0001
diff VCAs-SIGs VCAs	1	0.50708055	0.50708055	32.06	<.0001
diff VCAs SIGs	1	0.00226414	0.00226414	0.14	0.7061

Table 21: Uncertainty Thinking Difference at G1 Among Conditions Analysis

Since the p-value is less than 0.0001, there is a significant difference among the conditions. As such, there is a need to know where the difference lies. VCAs-SIGs Group has a difference with SIGs Group/3 and SIGs Group has no difference with VCAs Group. Again, it can be said that joining channels of nonverbal information, both gestural and graphical, does create a difference in perceived participation within the uncertainty/thinking measure.

Question Five
Is X2 associated with the hypothesis?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

This question is asking whether the measure uncertainty/thinking (X2) is associated with conditions. The test of independence is considered, that is, the chi-square test. For X2's response, statistic=51.8211 with p-value<0.0001. Hence, we say that there is a difference among conditions of X2's response. This result does hold true for the hypothesis.

Section Seven Web Survey Questionnaire Results
M5: Positive Feedback Measure

In section seven, participants were asked to assess, who and how from the six student actors demonstrate positive feedback in the video recording. They were also asked to write in their own words why they made a particular selection. Finally, they were asked to select the mechanism they would choose to demonstrate positive feedback, if participating in the same online learning environment.

Descriptive and Qualitative Analysis

Results show that the majority of the participants of VCAs-SIGs Group chose the student actors using both verbal and gestural channels to demonstrate positive feedback and most of the participants (48%) in SIGs Group. Whereas in VCAs Group, the majority of the participants (83%) made their choice based

on the verbal channel. That is, the majority of the participants would just say "yes" or raise their hand to demonstrate agreement.

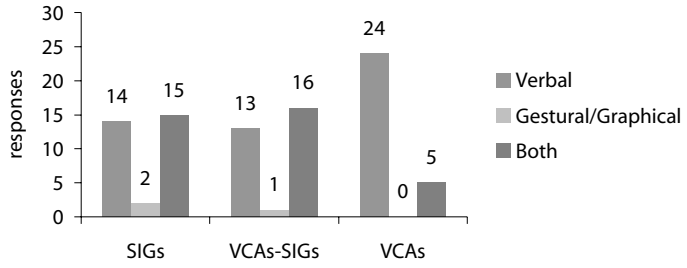


Figure 54: Positive Feedback Assessment Graph

When asked to write how they selected the student actors, the majority of the participants (41%) were neutral. 53% of VCAs-SIGs Group responses were explained by only using the gestural channel to demonstrate positive feedback. Whereas, in SIGs Group, most of the participants (48%) did not have an opinion on their choices. Moreover, in VCAs Group, participant's responses tied between not having an opinion (45%) and basing their answers on the verbal channel (45%).

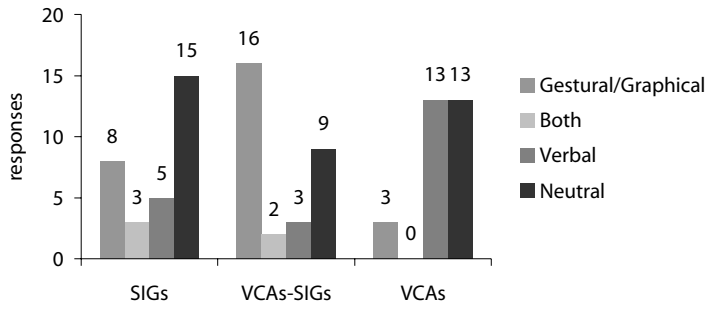


Figure 55: Positive Feedback Qualitative Assessment Graph

Some of the descriptions included participants not "remembering" the outcome or cue mechanism:

"I don't recall any visual clue that they agreed like numbers or highlights. I remember Kim saying "I agree' and maybe one other but I only remember Kim clearly" (VCAs-SIGs Group)

"I did not notice anyone raising their hand in agreement, so I did not check anyone. I also don't remember anyone saying - I agree- I must have missed something there" (VCAs-SIGs Group)

However, as it has been shown, many participants could assess the positive feedback, based on the role of nonverbal information:

"The teacher asked a question and they raised their hands in agreement" (SIGs Group)

"It is easier to recognize the motion of a person than his speech especially, if everyone speaks at the same time" (VCAs-SIGs Group)

"It was difficult to recognize people agreeing or disagreeing, because they all spoke so quickly and did not give visual identification" (VCAs Group)

When participants were asked to select the interaction mechanism they would use in this type of environment, most of the participants from SIGs Group (42%) answered they would use both the verbal and gestural channels, 43% of the responses in VCAs-SIGs Group were based on only the verbal channel, as well as the majority of the participants (59%) of VCAs Group.

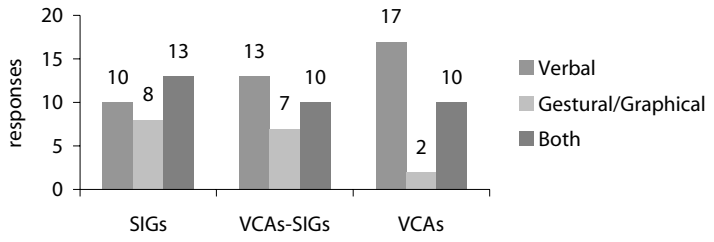


Figure 56: Positive Feedback Interaction Choice Graph

In general, the positive feedback assessment measure had various results, but it can be summarized that all would use both gestural and verbal channels for perceived participation.

Statistical Analysis

With six students in the video, respondents were supposed to place a checkmark next to whom they thought demonstrated positive feedback. They could checkmark as many as applied. It is expected that students, who gesture raising their hands (X1, X2 and X3) in the video simulation class, have the highest ratings.

Question One

Is there a difference between G1 and G2 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

The T test statistical analysis is performed to test the difference of positive feedback between groups (Y). Define a variable Y=(X1+X2+X3)/3-(X4+X5+X6)/3. If the mean of Y is not 0, then we may say that there is a difference between G1 and G2.

Mean	0.281481	Std Deviation	0.39947

Test	Statistic	p Value
Student's t	t 6.684734	Pr > |t| <.0001

Table 22: Positive Feedback Group Difference Analysis

Since the p-value is less than 0.0001, there is a difference between G1 and G2. As such, it can be said that students, who use gestures and/or graphic interfaces (G1), are perceived differently than the student actors, who do not (G2) within the positive feedback participatory measure.

Question Two
Is there a difference among conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

A one-way ANOVA is performed to test the difference of positive feedback among conditions.

Dependent Variable: PF Difference Between Groups

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.90520881	0.45260440	2.96	0.0570
Error	87	13.29726033	0.15284207		
Corrected Total	89	14.20246914			

R-Square	Co-eff Var	Root MSE	Mean
0.063736	138.8902	0.390950	0.281481

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	0.90520881	0.45260440	2.96	0.0570
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	0.90520881	0.45260440	2.96	0.0570

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
Diff SIGs VCAs-SIGs	1	0.01385078	0.01385078	0.09	0.7641
Diff VCAs-SIGs VCAs	1	0.75862935	0.75862935	4.96	0.0285
Diff SIGs VCAs	1	0.58817400	0.58817400	3.85	0.0530

Table 23: Positive Feedback Condition Difference Analysis

Since the p-value is 0.0570, there is a difference among conditions at the level of significance 0.1, but no difference at 0.05. Since there is a difference among conditions, there is a need to know where the difference lies. At the level of significance α=0.1, there is no difference between SIGs Group and VCAs-SIGs Group, and there is a difference between VCAs Group and SIGS Group and VCAs-SIGs Group. In other words, it can be said that having a single or joined

channel of nonverbal information does not make a difference. However, having the graphical visual channel of information (VCAs) within the positive feedback participatory measure is statistically different among other conditions having a single channel of nonverbal information.

Question Three

Is there a difference among the three students of G1 over all conditions?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

Three sets are considered in the analysis of the difference of X at G1 within the positive feedback measure: (X1*X2, X2*X3, X1*X3). The "McNemar's Test" is used for dependent proportions of each set, because of the dichotomous nature of the response (0/1).

For X1 and X2, Statistic=2.1304 with p-value=0.1444.
For X1 and X3, Statistic=20.8286 with p-value<0.0001.
For X2 and X3, Statistic=15.3846 with p-value<0.0001.

X3 has a difference with X1 and X2, but X1 has no difference with X2. That is, participants are able to better differentiate the meaning and performance of the positive feedback participatory measure regardless of the difference, since all G1 student actors perform the same gesture.

Question Four

Is there a difference among the conditions of G1?

responses	G1			G2		
	X1	X2	X3	X4	X5	X6
SIGs						
VCAs-SIGs						
VCAs						

A one-way ANOVA is performed to test the difference of positive feedback at G1 among conditions.

Dependent Variable: PF Difference at G1 Among Conditions

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1.49156401	0.74578201	5.86	0.0041
Error	87	11.07757179	0.12732841		
Corrected Total	89	12.56913580			

R-Square	Co-eff Var	Root MSE	Mean
0.118669	85.26052	0.356831	0.418519

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	1.49156401	0.74578201	5.86	0.0041

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	1.49156401	0.74578201	5.86	0.0041

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
diff VCAs-SIGs SIGs	1	0.18539118	0.18539118	1.46	0.2308
diff VCAs-SIGs VCAs	1	1.44487521	1.44487521	11.35	0.0011
diff VCAs SIGs	1	0.62081399	0.62081399	4.88	0.0299

Table 24: Positive Feedback Difference at G1 Among Conditions

There is a difference among conditions with p-value=0.0041. As such, there is a need to know where the difference lies. There is no difference between SIGs and VCAs-SIGs. But, there is a difference between VCAs and other conditions. Again, it can be said that having a single or joined channel of nonverbal information does not make a difference. However, having the graphical visual channel of information (VCAs) within the positive feedback participatory measure is statistically different among the conditions having a single channel of nonverbal information.

Section Eight
Gestures in Online Learning Environments

In this section, participants are asked about their awareness of gestures and/or graphic interfaces from the videos. Also, they are asked about their opinion of using gestures in online leaning environments, as well as

recommendations to improve the communication space. Except participants of SIGs Group, participants are tested in the understanding of the VCAs employed in the experiments.

Visual Co-Activations

Results are significantly positive in that most of the participants did match the VCAs of SIGs, accordingly. That is, the majority of the participants (81%) are able to recognize the graphical meaning of active participation associated with the red border of the gesturer; 68% recognize the graphical meaning of uncertainty/thinking associated with the dotted red border of the gesturer; 88% recognize the graphical meaning of call for attention and positive feedback associated with numbers; and 78% recognize the graphical meaning of avoid attention associated with half opacity. Results across conditions are slightly different (see Appendix C for more detailed results). In other words, data show that the graphical meaning was better recognized, when both channels of nonverbal information gestural and graphical are jointed. Thus, there is higher understanding of the meaning of VCAs of SIGs, when both channels are incorporated.

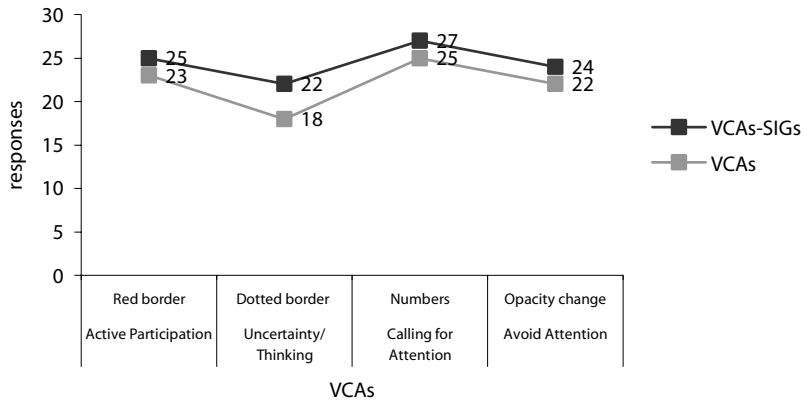


Figure 57: Visual Co-Activation Meaning Assessment Graph

Relevance of Gestures in Online Learning Environments

Results show that 84% of the participants within this study agree that gestures are an efficient communication mechanism for online learning environments. Data show that across the studies, most of the participants are aware of the use and amount of gestures and/or graphic interfaces during the experiments (see Appendix C for more detailed results). Moreover, over one third of the participants (35.5%) stated that gestures are efficient, since they are effective dynamic tools that can aid better inter- and intra-communication among the class (i.e. acting as regulators of conversation), and 19% stated that gestures are more visible and better recognizable than the verbal channel. Following is a summary of their statements:

> *"Hand gestures will add to whatever is being said"*
>
> *"It shows interest"*
>
> *"Easier to shift attention to people, if they are uncertain without interrupting the speaker"*
>
> *"Provide visual cues to understanding and willingness to participate in discussion"*
>
> *"It draws more attention to you and helps expression. Since the picture is small - extra expression helps, because you can't read lip".*
>
> *"They help you gain attention or allow the teacher to know what you are thinking, when it is not appropriate for you to speak"*

In general, the SIGs group data regarding the participation assessment shows that the gestural channel alone is not sufficient. The population stated (61%) that there is a need for other mechanisms. When asked for recommendations, 42% couldn't define why or what, but out of the other six recommendation categories (see Appendix C), 25% of the population recommended adding visual mechanisms such as the use of color cues, zooming in/out on people,

incorporating signals, in order to aid the interaction communication process. Following is a summary of their statements:

> *"Maybe if the box around the person talking were highlighted to indicate who was talking… It was difficult to figure out who actually was going to talk, when 3 people raised their hands"*
>
> *"I am certain there are (other mechanisms), but I am not certain what they are that will make things more interactive"*
>
> *"A way to press a key on the computer that will light up saying who is next to talk...sort of like a game show buzzer"*

Based on of the participants comments, data collection demonstrates the need of developing collaborative devices for a group, which gives the foundations for the testing of the performance of visual cues or graphic interfaces in online environments.

Discussion

Demographic analysis shows almost no variance across the studies, regardless of the volunteer sample used. As such, the demographics percentages are very close along the conditions without having a significant effect on the findings.

Movement to Communicate Participation

Students move their hands to send messages in the classroom. The majority barely *consciously* pays attention to its performance and message. But the hand movements are not merely isolated movements, like a student raising the hand to ask for a question. At a deeper level, hand movements may tell us a more ample perspective of the cognitive status of the students in the classroom. Thus, the need to augment its meaning within a group.

From the presented vocabulary of gestures found in learning environments, the next step was to test its role to be used along with graphic interfaces to facilitate communication in a group with the use of computers, when using

multi-videoconferencing, a synchronous online interaction. Four different gestures were tested within five participatory measures. Below, it is a summary of the statistical analysis results of the perceived participation within the participatory measures.

Statically Significant (α0.05 and α0.10)	**M1** Active participation *Roll hands and/or red frame (X1)*	**M2** Call for attention *Raise hand and/or numbers (X1, X2, X3)*	**M3** Avoid Attention *Crossed arms and/or half opacity (X3)*	**M4** Uncertainty/ Thinking *Hand on chin/cheek and/or dotted red frame (X2)*	**M5** Positive Feedback *Raise hand and/or numbers (X1, X2, X3)*
Q1 Difference G1 and G2	Yes	Yes	Yes	Yes	Yes
Q2 Difference among conditions	No	No	Yes	Yes	Yes
Q3 Difference X1, X2 and X3	Yes	Yes	Yes	Yes	Yes
Q4 Difference G1 among conditions	No	Yes	Yes	Yes	Yes
Q5 Difference of M among conditions	No	-	Yes	Yes	-

Table 25: Summary Presence of Statistical Significance of Each Measure

Results show that participants from all the studies/conditions rated all G2—actors who did not use gestures or/and graphic interfaces the lowest in comparison to all G1—actors who did use gestures or/and graphic interfaces. The majority of the measures proved that there are differences among conditions. Participants were able to distinguish the gesture meaning from one to another, even from a gesturer or group of gesturers. Moreover, participants not only were able to distinguish between the SIGs-VCAs

measures, but also those measures performed better in VCAs-SIGs Group. Thus, the majority of the participatory measures prove the hypothesis.

What the results tell about: What are the visual channels that best represent and facilitate participation and feedback within online learning environments? And does the visual representation of SIGs augment and promote better means for understanding the message being conveyed? Answering the research questions, results indicate that joining both channels of nonverbal information SIGs and VCAs have been proved to perform better. Thus, the visual co-activations of spontaneous interactive gestures, in the context of online learning environments, are powerful tools of communication, when tested within participatory measures. As such, **the major finding of this research is that the majority from all the participatory measures, VCAs of SIGs does facilitate participation communication in online learning environments.**

	SIGs Group	**VCAs-SIGs Group**	**VCAs Group**
M1 How the most	Verbal (58%)	Verbal (60%)	Verbal (76%)
M1 How the least	Verbal (71%)	Verbal (60%)	Verbal (79%)
M2 Assess	Both (84%)	Both (90%)	Both (65%)
M2 How	Gestural (71%)	Gest/Graph (93%)	Graphical (93%)
M2 Select Mech	Gestural(68%)	Gest/Graph (63%)	Both (55%)
M3 Assess	Verbal (58%)	Verbal (57%)	Verbal (72%)
M3 How	Gestural (87%)	Gest/Graph (77%)	Graphical (45%)
M3 Select Mech	Verbal (87%)	Verbal (87%)	Verbal (76%)
M4 Assess	Verbal (48%)	Verbal (47%)	Verbal (69%)
M4 How	Gestural (77%)	Gest/Graph (87%)	Verbal, Neut (34%)
M4 Select Mech	Verbal (55%)	Verbal (80%)	Verbal (59%)
M5 Assess	Both (48%)	Both (53%)	Verbal (83%)
M5 How	Neutral (48 %)	Gest/Graph (53%)	Verbal, Neut (45%)
M5 Select Mech	Both (42%)	Verbal (43%)	Verbal (59%)

Table 26: Summary of Qualitative Participation Assessment for Each Measure

Above, it is a summary of the qualitative participation assessment within the participatory measures. Recall participant responses were coded under four

categories: verbal only, graphical/gestural only, both and neutral or no opinion.

Results shows that as the more visual co-activation are incorporated the less participants focus on the verbal channel. That is, in average when incorporating VCAs of SIGS, participants relied slightly less on the verbal channel to assess participation. Rather their assessments were higher in assessing participation communication based on gestural/graphical interfaces. Most of the participants selected that they assess participation more from the verbal channel. However, when describing how they made their assessment, the majority was based on the gestural/graphical or both. It can be said that participant may consciously think about how the assess participation through the different channels, but at the deeper level, gestural/graphical information plays an important role in that assessment. As such, **a major finding of this research is that the less cognitive effort participants use to understand/assess the communication interaction, the more likely to understand the content of the message, rather than the mechanism used.**

Chapter 10

Recommendations for Future Research

Based on the conclusions of the project, the researcher highly recommends a further series of studies, related to the use of nonverbal information in online learning environments. This present effort should be seen as the first step of studying gestures and visual co-activations in the context of education. As such, in the next sections, the researcher proposes relevant topics for conducting future research.

Credibility of Findings

Due to the nature and funding of the study, this research was performed by a single researcher working alone. Observer Video Pro was used to add an objectified perspective in analyzing observational data. Moreover, data was observed several times to add credibility of the findings. However, the researcher's main recommendation is: if qualitative observation methods are incorporated, the study should employ multiple researchers for analyzing data in order to further validate the credibility of the findings.

Cultural Aspects of Gestures in Learning Environments

This researcher performed ethnographic studies in a specific institution within the United States. Although rich data was collected, it is stated by many researchers in the field of gesture studies, that there is a strong cultural component attached. That is, gesture performance differs from culture-to-culture. Therefore, the researcher recommends incorporating specific and varied cultural aspects in studying gestures in online learning environments. The researcher suggests conducting ethnographic studies in different institutions from different cultures in order to understand the commonalities, differences and scope of gesture performance and meaning.

Gesture Performance Across Time

This researcher performed ethnographic studies for a specific period of time. A limited number of observations were conducted in a single classroom environment. Though rich data was collected from the field, it was only based on three consecutive observations. Increasing the quantity of observations, and studying other classroom environments and strategies should achieve a more exhaustive list of classroom gestures. Also, the researcher questions the incorporation of time (temporal aspects) as a dependent variable affecting the gesture performance. The researcher highly recommends extending the number of observation sessions for further study of the variability of gesture performance and for more precise results.

Timing Gesture Perception and Meaning

This researcher performed experimental studies in which participants were asked to recognize student actors, who performed specific gesture measures. The goal was to understand how visual mediums amplify meaning and facilitate recognition of behavior. Participants were not tested to the ability to manage the visual information at the scale and frequency of gesture use in the classroom. The researcher believes that time should be studied in which how fast a gesture and meaning is recognized. The goal is to have a comparative analysis of how a gesture meaning is processed across different measures.

Studies on Visual Co-Activations

This researcher is concerned with understanding the role of nonverbal information, both gestural and graphical. The purpose is to understand whether redundancy of information facilitates interactive communication. Research findings suggest that having both gestural and graphical information provides a more accurate understanding of interactive communication. VCAs of SIGS were designed and tested in the experimental study. Results from the web survey questionnaire show almost perfect understandings of the selected VCAs to the meaning of SIGs. Though the results were positive in confirming the hypothesis, the researcher strongly

recommends conducting research on the efficacy of the selected VCAs. That is, performing studies on the interpretations of different VCAs towards a specific SIGs measure and testing all possible means of information display and meaning classification.

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Appendices

Appendix A

North Carolina State University
Institutional Review Board for the Use of Human Subjects in Research
SUBMISSION FOR NEW STUDIES

Title of Project: *Visualizing Communication Structures of Non-Verbal Information for Online Distance Education*

Principal Investigator: *Claudia Rebola* Department: *PhD in Design, College of Design*

Source of Funding (required information): *GSSP*

Campus Address (box number): *7701*

Email: *cbrebola@ncsu.edu* Phone: *919-389-2302* Fax: *none*

Rank: ☐ Faculty

☒ Student: ☐ Undergraduate ☐ Masters; or ☒ PhD

☐ Other:

If rank is not faculty (i.e. student or other), provide the name of the faculty sponsor overseeing the research: *Haig Khachatoorian*

Faculty Sponsor's email: *fghk@mindspring.com* Campus Box: *7701* Phone: *919-515-8331*

Investigator Statement of Responsibility
"As the Principal Investigator, my signature testifies that I have read and understood the University Policy and Procedures for the Use of Human Subjects in Research. I assure the Committee that all procedures performed under this project will be conducted exactly as outlined in the Proposal Narrative and that any modification to this protocol will be submitted to the Committee in the form of an amendment for approval prior to implementation."

_____ _____
Principal Investigator's Signature* Date

Faculty Sponsor Statement of Responsibility
"As the Faculty Sponsor, my signature testifies that I have reviewed this application thoroughly and will oversee the research in its entirety. I hereby acknowledge my role as principal investigator of record."

_____ _____
Faculty Sponsor's Signature* Date
*electronic submissions to the IRB are considered signed via an electronic signature

PLEASE COMPLETE IN DUPLICATE AND DELIVER TO:
Institutional Review Board, Box 7514, NCSU Campus (lower level of Leazar Hall)
****
For IRB office Use Only

Review Received: ☐ Administrative ☐ Expedited ☐ Full Board

Review Decision: ☐ Approve ☐ Approve with Modifications ☐ Table ☐ Disapprove

Reviewer_____ Signature_____Date _____

North Carolina State University
Institutional Review Board for the Use of Human Subjects in Research
PROPOSAL NARRATIVE

If at any time you have questions or difficulties while completing IRB forms, please feel free to contact Deb Paxton at debra_paxton@ncsu.edu or 919-515-4514.

In your narrative, please address each of the questions below. Keep in mind that the more details that you provide, the easier an IRB reviewer will be able to understand your research and reach a prompt decision.

A. INTRODUCTION

1. In lay language, please briefly describe your research, its purpose, procedures, and expected contribution to its field or to the general population.
This dissertation focuses on a multi-disciplinary approach to the visualization of Spontaneous Interactive Gestures (SIGs) produced by students and teachers in learning environments, and how they can best be used as interfaces to improve group educational experiences in online environments for distance education. Gestures possess a symbolic representation of meaning that might augment shared information in communication spaces. Literature indicates that the use of gestures in computer applications is an effective natural means of communication and plays a crucial role in teaching and learning, facilitating interaction among participants. The aim is to develop foundations for more interactive means of synchronous communication for future applications in distance education, based on SIGs and Vision-Based Interfaces (VBI) for computer-mediated communication (CMC). The study employs a multiple-data collection procedure, a two-phased developmental design in which qualitative studies - identifying participatory SIGs - and quantitative methods - testing visual co-activations and measuring participation from SIGs - are used to understand the role of SIGs in distance education. This dissertation envisions research in the use of innovative technologies to promote learner-centered contemporary educational practices for providing better online instructional environments that support more fluid and integrative forms of group discourse.

2. If this is student research, indicate whether it's for a course, thesis, or dissertation.
Dissertation

B. SUBJECT POPULATION

1. How many subjects will be involved in the research?
Approximately 30 subjects will be involved in the research from two differientiated courses at NCSU, one course delivered in traditional settings and another in online distance education.

2. Describe how subjects will be recruited. If flyers, advertisements, or recruitment letters will be used, please attach copies of those documents.
Subjects will be recruited from the NC State Universty courses database. Two courses delivered both in traditional and online will be observed. Dr. Douglas Sanders is the instructor of the courses of 'Advance Vegetal Crop Management' HS-590E-002,HS-590E-610 and HaigKhachatoorian of 'Profesional Practice of Industrial Design' ID-262/582-001 in the Spring 2004 semester at NC State University. Students enrolled in the courses selected will comprise the sample population. Dr. Douglas Sanders and Professor Khachatoorian has granted persmission to the researcher to observe their class dynamics. Interviews will be conducted with 3 randomly selected students from the class list for each course. They will be contacted via e-mail to participate in the interview. For the traditional course, student interviews will be arranged upon participant selection of

date, time and place during the observation period. For the online course, student interviews will be performed online via video-conferencing upon participant selection of date and time, during the observation period.

3. List specific eligibility requirements for subjects, describe screening procedures, and justify criteria that will exclude otherwise acceptable subjects.
   N/A

4. Explain and justify and sampling procedures that exclude specific populations.
   N/A

5. Disclose any relationship between researcher and subjects, such as teacher/student or employer/employee.
   N/A

6. Check any vulnerable populations that you will intentionally include in the study:
   - ☐ Minors (under the age of 18) – if you will involve minors in your study, you must make provisions for parental consent and minor assent to the research
   - ☐ Pregnant women
   - ☐ Persons with mental, psychiatric, or emotional disabilities
   - ☐ Persons with physical disabilities
   - ☐ Elderly
   - ☐ Students from a class taught by the Principal Investigator
   - ☐ Prisoners
   - ☐ Other vulnerable populations: *N/A*

   If any of the above are used, justify the necessity for doing so. Please indicate the approximate age range of minors to be involved. *N/A*

C. PROCEDURES TO BE FOLLOWED

1. In lay language, describe completely and with good detail all the procedures involving human subjects that will be followed during the course of the study. Provide sufficient detail so the committee is able to adequately review the research.
   Phase One: Qualitative Research Approach
   Traditional course -
   Fieldwork will be conducted in courses delivered in traditional settings- a physical classroom/place where students meet. Two techniques will be utilized: direct observations and interviews. Observations will be performed in one purposefully chosen graduate course at NCSU with a teacher and approximately 15 students (i.e. HS-590E-002 and ID-262/582-001). The course will be based on a discussion-type of class. The researcher will conduct field observations using video cameras and a self-designed observation tool to record a total of three lectures. Post-observation interviews will be performed with the teacher and three randomly selected students from the class. Interviews will be video-recorded. Location and time will be assigned by the participant; and recording of the interview (video and sound) upon participant's consent.
   Online course -
   Observations of online settings will be performed in one purposefully chosen graduate course from the distance education initiative at NCSU, with a maximun of 15 people performing the video-conferencing (i.e. HS-590E-610). The researcher will conduct field observations recording the online class using usability lab equipment and the self-designed observation tool to record a total of three lectures. Post-observation interviews will be performed with the teacher and three randomly selected students from the class. Interviews will be executed via video-conferencing and recorded with usability lab equipment. Time will be assigned by the participant; and recording of the interview upon participan's consent.

mainly naturalizing the human-to-human communication, mediated by computers. Moreover, it is to make meaningful the role of the human body within computer applications. In summary, it is critical to learn from face-to-face human interactions to assist in designing computer interfaces/tools that are bounded in natural social/contextual phenomena.

F. COMPENSATION

Explain compensation that subjects will receive for participating in the study, as well as provisions for the withdrawal of a subject prior to completion of the study.
No compensation will be given to the participants.

1. If class credit will be offered for participation, list the amount given and alternate ways to earn the same amount of credit.
   No class credit will be given.

G. COLLABORATORS

If you anticipate that additional investigators (other than those listed on the cover page) may be involved in the research, list them here indicating their institution, department and phone number.
No additional investigators will be involved in this dissertation research study.

H. ADDITIONAL INFORMATION

1. If a questionnaire, survey, or interview instrument is to be used, attach a copy to this proposal

2. Attach to this document a copy of the informed consent document that you will use

3. If your study involves minors, attach a copy of the parental permission and child assent documents that you will use.

4. Please provide any additional materials or information that may aid the IRB in making its decision.
   See attached.

Revised 6/2003

North Carolina State University
Institutional Review Board For The Use of Human Subjects in Research
GUIDELINES FOR PREPARATION OF INFORMED CONSENT FORM

An **Informed Consent Statement** has two purposes: (1) to provide adequate information to potential research subjects to make an informed choice as to their participation in a study, and (2) to document their decision to participate. In order to make an informed choice, potential subjects must understand the study, how they are involved in the study, and what sort of risks it poses to them and whom they can contact if a problem arises (see informed consent checklist for a full listing of required elements of consent). Please note that **the language used to describe these factors must be understandable to all potential subjects, which typically means an eighth grade reading level.** The informed consent form is to be read and signed by each subject who participates in the study **before** they begin participation in the study. A duplicate copy is to be provided to each subject.

If subjects are **minors (i.e. any subject under the age of 18)** use the following guidelines for obtaining consent:

0-5 years old – requires signature of parent(s)/guardian/legal representative
6 – 10 years old - requires signature of parent(s)/guardian/legal representative and verbal assent from the minor. In this case a minor assent script should be prepared and submitted along with a parental consent form.
11 - 17 years old - requires signature of both minor and parent/guardian/legal representative

If the subject or legal representative is *unable to read and/or understand the written consent form*, it must be verbally presented in an understandable manner and witnessed (with signature of witness). If there is a good chance that your intended subjects will not be able to read and/or understand a written consent form, please contact the IRB office (919-515-4514) for further instructions.

For your convenience, attached find a sample consent form template that contains necessary information. In generating a form for a specific project, the principal investigator should complete the underlined areas of the form and replicate the bold areas.

North Carolina State University
INFORMED CONSENT FORM for RESEARCH

Title of Study Visualizing Communication Structures of Nonverbal Information for Online Distance Education

Principal Investigator Claudia Rebola Faculty Sponsor Haig Khachatoorian, IDSA

We are asking you to participate in a research study. The purpose of this study is to understand the role of gestures in human-to-human communication developed in learning environments.

INFORMATION
If you agree to participate in this study, you will be asked to answer a set of open-ended questions for a maximum of one hour. I will use a video camera to record the interview. The purpose of recording the interview is to have a recovery of our conversation to better understand the role of gestures.

RISKS Not applicable.

BENEFITS
List the benefits you anticipate will be achieved from this research, either to the subjects, others, or the body of knowledge. If there is no direct benefit expected to the subject, but knowledge may be gained that could help others, state this.

CONFIDENTIALITY
The information in the study records will be kept strictly confidential. Data will be stored securely in my possession. Once my dissertation research is complete, I will destroy any material I have used with your participation **No reference will be made in oral or written reports, which could link you to the study.**

COMPENSATION Not applicable.

EMERGENCY MEDICAL TREATMENT (if applicable) Not applicable.

CONTACT
If you have questions at any time about the study or the procedures, you may contact the researcher, Claudia Rebola**, at** 2339 Champion Court, Raleigh, NC 27606, crebola@hotmail.com**, or** [919.389.2302]**. If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Dr. Matthew Zingraff, Chair of the NCSU IRB for the Use of Human Subjects in Research Committee, Box 7514, NCSU Campus (919/513-1834) or Mr. Matthew Ronning, Assistant Vice Chancellor, Research Administration, Box 7514, NCSU Campus (919/513-2148)**

PARTICIPATION
Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed at your request.

CONSENT
"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may withdraw at any time."

Subject's signature_____ **Date** _____

Investigator's signature_____ **Date** _____

2. How much time will be required of each subject?
   Observations: the total lengh of the class.i.e.50 minutes.
   Interviews: no more than 1 hour.

D. POTENTIAL RISKS

1. State the potential risks from the research (psychological, social, financial, legal, physical, or otherwise). State how you plan to minimize these risks.
   No potential risks.

2. Will there be a request for information that if accidentally made public could embarrass the subjects or reasonably place them at risk of criminal, social, or professional harm?
   Names will remain anonymous. During the study, nicknames will be assigned to the participants in order to maintain their confidentiality. Furthermore, there will be no requests for information that could embarrass the subjects.

3. Could any of the study procedures or information collected produce stress, anxiety, or psychological harm? If yes, please justify the need for such procedures or information, and describe methods you will take to minimize the harm a subject encounters (e.g. you will provide or arrange for psychological counseling for those subjects who experience distress due to your study).
   None of the study procedures produce stress, anxiety or psychological harm.

4. Describe methods for protecting your subjects' confidentiality. How will data be recorded and stored? Will any identifiers be collected? If so, how and why? If you will collect identifiers, will you destroy the link between subject identity and data at some point? If you are collecting audio or video recordings, do you plan to destroy the recordings after the research is complete?
   The use of nicknames will be the primary method to protect subject's confidentiality.
   Data recorded in video-tape and hand writing observation tools will be destroyed upon completion of the dissertation.
   There will be no identifiers.

5. If your research will be reported in a case study format, how will you protect individual subjects' responses/information?
   Individual subjects' responses/information will be protected by refering to the nickname code assigned during the observation/coding phase.

6. Is there any deception of subjects in this study? If yes, please describe the deception, justify it, and provide a debriefing procedure.
   There is no deception of subjects in this study.

E. POTENTIAL BENEFITS

Please address benefits expected from the research. Please note that this does not include compensation for participation, in any form. Specifically, what, if any, direct benefit is to be gained by the subject? If no direct benefit is expected, but indirect benefit may be expected (i.e. to general society), please explain.

There are different benefits of conducting this dissertation research. First, is to understand that the human body possesses unique communicative affordances, able to augment the visibility of human behavior in shared information spaces within learning group interactions. Therefore, it is crucial to study the student subjects and how they interact in natural occuring situations, focusing on the role of gestures in the context of learning. This information will be used to identify a vocabulary consisting of the gestures, which promote participatory outcomes across learning environments. This non-verbal language can be applicable in developing more humane communication devices for computer applications. The purpose of observing and interviewing students and teachers is to have meaningful data to translate it for the future computer paradigm by having computers not only adaping to the user, but

North Carolina State University is a land-grant university and a constituent institution of The University of North Carolina

Office of Research and Graduate Studies

NC STATE UNIVERSITY

Sponsored Programs and
Regulatory Compliance
Campus Box 7514
1 Leazar Hall
Raleigh, NC 27695-7514

919.515.7200
919.515.7721 (fax)

From: Debra A. Paxton, Regulatory Compliance Administrator
North Carolina State University
Institutional Review Board

Date: February 6, 2004

Project Title: Visualizing Communication Structures of non-Verbal Information for Online Distance Education

IRB#: 028-04-2

Dear Ms. Rebola:

The research proposal named above has received administrative review and has been approved as exempt from the policy as outlined in the Code of Federal Regulations (Exemption: 46.101.b.2 and b.1). Provided that the only participation of the subjects is as described in the proposal narrative, this project is exempt from further review.

NOTE:

1. This committee complies with requirements found in Title 45 part 46 of The Code of Federal Regulations.
   For NCSU projects, the Assurance Number is: FWA00003429; the IRB Number is: IRB00000330

2. Review de novo of this proposal is necessary if any significant alterations/additions are made.

Please provide your faculty sponsor with a copy of this letter. Thank you.

Sincerely,

Debra Paxton
NCSU IRB

SIGs fieldwork
Observation class: Date: Start time: End time:
Coding: Q=question A=answer SIG=use of gesture S=speech SS=both gesture and speech S1,S2…=students R1, R2…=remote students P=professor RP=remote professor

Who	Interaction	Response	Who	Time

Notes Descriptive

Notes Reflective

SIGs mapping

class ☐ date ☐ time ☐

user

characteristics
- ☐ teacher
- ☐ student
- ☐ male
- ☐ female
- ☐ young
- ☐ adult

location
- ☐ intimate
- ☐ personal
- ☐ social
- ☐ n/a

environment
- ☐ noisy
- ☐ dark
- ☐ close
- ☐ cold
- ☐ calm
- ☐ luminous
- ☐ open
- ☐ warm
- ☐ n/a

activity
- ☐ seating
- ☐ standing
- ☐ walking
- ☐ running

gesture

production
- ☐ alone
- ☐ + speech
  - word emphasis

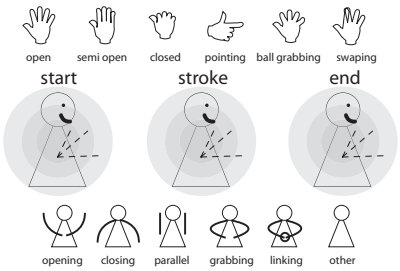
visibility
- ☐ visible
- ☐ hidden

interaction
- ☐ oneself
- ☐ a group
- ☐ situation
- ☐ a person
  - student
  - teacher

type
- ☐ conscious
- ☐ uncons.
- ☐ static
- ☐ dynamic
- ☐ iconic
- ☐ metaphoric
- ☐ deictic
- ☐ beat
- ☐ emblem
- ☐ instrument
- ☐ bodily
- ☐

usage
- ☐ one
  - left
  - right
- ☐ two
- ☐ objects in hand

movement



sequence
- ☐ same gesture
- ☐ senses
  - touch
  - smell
  - visual
- ☐ other hand gesture
- ☐ n/a

meaning

production
- ☐ serious
- ☐ joke

category
- ☐ greeting
- ☐ feedback
- ☐ mating
- ☐ profane
- ☐ emphasis
- ☐ other

function
- ☐ call for attention
- ☐ avoid attention
- ☐ certainty
- ☐ uncertainty
- ☐ positive feedback
- ☐ negative feedback
- ☐ active role
- ☐ inactive
- ☐ other

signals
- ☐ calm
- ☐ anxious
- ☐ interest
- ☐ non interest
- ☐ friendly/happy
- ☐ angry/sad
- ☐ dominance
- ☐ subordinance
- ☐ other

notes

Thursday February 12, 2004

Dear Student,

I am working towards my doctoral degree in Information Design. My dissertation research project is about understanding the role of gestures in computer-mediated communication in the context of distance education. During this semester, I will concentrate on performing the data collection phase. In my dissertation study, there is a strong qualitative approach within observations and interview methods. As you have noticed during the past weeks, I have been conducting observations on the course you are enrolled in. It has been a valuable source of information. However, I still need to perform short interviews to better validate my observation studies on your course.

I am writing to you, because I would like you to participate in the interview. It is a very simple task I would ask from you. The interview will not be longer than an hour. I will ask your opinion about gestures through different open-ended questions. For example, I will show you a short segment of a class on the computer, where you would need to tell me what you think a person is trying to say, based on the gesture s/he is performing. Your answers will be videotaped, so that I can have a better recovery of your participation. Sometimes researchers discover meaningful data, after watching a tape several times, especially in gesture-related studies, where a movement done in less than a second can be easily missed. For your benefit, all information you will be providing me will remain confidential at all points of my dissertation and in any future publications. In the interview day, I will bring a formal copy of my accepted IRB (Institutional Review Board) application form to conduct observations and interview in your course, in which I will ask you to sign my promise of your confidentiality. Furthermore, once the dissertation study is completed, I will destroy any evidence/reference material that involves you.

I really hope you will grant me the opportunity to meet with you. As such, and for your convenience, you will need to respond to my e-mail (cbrebola@ncsu.edu), if you agree to participate. Also, I ask that you let me know when it will be convenient for you to meet with me (date, time and place). Otherwise, I will not be contacting you again.
Please do not hesitate to contact me at my cell phone 919.389.2302 or my office at 919.515.8361, if you have any additional questions on any issue related to the study and your interview participation, and I will be pleased to address these.

Looking forward to hearing from you.

Claudia Rebola
PhD Candidate
Information Design
College of Design
NC State University

Interview Guide (Protocol) for Students

1. Introduction

a. Greet participant
b. Begin to establish rapport
c. Give explanation of the project
The role of gesture in the classroom environment to be used as interfaces for computer mediated distance education
d. State purpose of the project/interview
Use interviews to better validate my observations
No longer than 1 hour
e. Give and sign consent form
Explain anonymity and confidentiality
f. Explain note-taking/ audio taping
g. Explain the use of interview guide and open-ended questions

2. Description/Demographics

Date	**Starting Time**	**Ending time**
Subject –age gender clothing perception -		
Location –space size lighting organization noise -		
Other		

3. Open-ended questionnaire

About their experience in the class

Can you describe your function in the HS590?
Are you attending other classes than HS590 at NCSU?
Are they similar style to HS590? How?
Is this the first time you are taking a class with remote lecturers via videoconferencing?
If no: How many have you taken? At NCSU? Are they similar settings?
Can you describe your experience in the class?
How do you feel in the class?
Do you feel comfortable? Is there anything that you don't like?
From your perspective, what do you think is wrong with the current system?
What are the things or features you would like to have in future distance education courses using teleconferencing?
What do you think about the settings of the class?
In which TV do you pay attention to? What about the others?
What do you see on the TV?
Where do you mostly focus attention?

About their participation in the class

Is it difficult for you to participate in this class?
Do you think that you can participate in this class as much as you do in your other classes?
What makes you not able to participate in the class?
How are you able to participate in the class? Can you give me examples?
What medium/mechanisms do you use to participate in class?

About others people participation

Do you think it is difficult for other people to participate in the class?
How are you aware when other people are trying to participate? Can you give me examples?
What about the participation of remote site people in the class?
How are you aware of their participation in the class?
Are you aware of the gestures you make during class? Can you give me examples?

About gestures

Can you perform what kind of gestures you perform during the following situations?

1. Demonstrating ask for participation
2. Demonstrating avoid participation
3. Demonstrating agreement /positive feedback
4. Demonstrating disagreement / negative feedback
5. Demonstrating understanding / certainty
6. Demonstrating misunderstanding / uncertainty
7. Demonstrating understanding that you are actively talking
8. Demonstrating being inactive

For each one of the above questions:
Can you recall what kind of gestures your classmates perform during class?

Participant's opinion on the project

Do you think that gestures are an important source of communication?
Do you know the type of research I am doing in the class?
Do you know about vision-based-interfaces? (Briefly explain)
Do you think it would be useful to have visual displays of people's participatory actions based on gestures?
For example, if someone wants to ask a question would raise the hand, and a visual graphic display (i.e. a yellow square in the screen) would help you visualize the person.
Do you want to ask me some specific question?

4. Closure

a. Make transition from interviews questions to conversation
b. Thank respondents for participation

Check if respondent is willing to participate in another interview if needed

Appendix B

Script for Demo Experimental Tool

Actors color code, alias names and majors/functions:

General indications → script
Peter: instructor
Kim: law/student
John: computer science/student
Lisa: education/student
Sara: design/student
Mike economics/student
Will: psychology/student

Class dynamics and conversation

Actor	Gesture	Script
00.00	All participants are in neutral position to begin the class. The body is straight and hands are resting on legs. Haig waits 5 seconds before speaking Haig starts speaking giving the introduction to the class. Haig asks students to introduce themselves to the class.	
Haig 00.05	NO SIGs	Welcome to this multidisciplinary course. My name is Peter. I will be the instructor for this class. Let's start by getting to know each other. Why don't you introduce yourself by telling me your name, your major, and your interest in this class?
00.20	People who gesture assume the following SIGs at the same time. Either hand can be used to gesture. Each SIGs is held for 3 seconds.	
Joe	1 raise hand	
Heather	1 raise hand	
Claudia	1 raise hand	
00.23		
	People who have just gestured assume the following SIGs until otherwise is asked:	
Heather	2 leaning cheek on hand	
Claudia	4 hands on desk	
Joe	4 hand on desk	
	Joe starts talking and assume the following SIGs:	
Joe 00.25	3 rolling hand	I am Mike. My major is in economics. And I am interested in this class to gain experience in interacting with people from other majors in order to be prepared for the professional workforce.
	Joe assumes the following SIGs:	
Joe	4 hands on desk	

Claudia 00.40	4 hands on desk	I am Lisa. I want to be a teacher. Therefore, this class is good practice to see how to engage students in different topics and perspectives in a classroom environment.
	Heather assumes the following SIGs:	
Heather 00.55	4 hands on desk	My name is Kim. I am pursuing a law degree. My interest in this class is to understand the role of lawyers in communicating among a multidisciplinary group.
	Once finished, Heather assumes the following SIGs:	
Heather	2 leaning cheek on hand	
	NO SIGs people introduce themselves in the following order:	
Sudeshna 01.10	NO SIGs	Hi. My name is Sara. My major is in graphic design. Multidisciplinary perspectives and collaboration are very important components in my discipline today.
Sean 01.25	NO SIGs	I am John. I am studying computer science. I am involved in this class because I want to know how different disciplines interact together towards the same topic.
Dan 1.40	NO SIGs	I am Will. I am majoring in psychology. Current trends in psychology are to understand people's interactions in a broader sense. I hope to acquire such knowledge in this class.
	Haig starts introducing the discussion topic and first question for participation:	
Haig 1.55	NO SIGs	Thank you very much introducing yourself. Today, we will be discussing the topic of the relationship between American Fast Food and Health with a multidisciplinary focus. Nearly two-thirds of Americans are obese or overweight. There is strong debate in trying to understand the causes of obesity. One of the major investigation streams of this topic is the role of fast food in the daily American lifestyle. Fast food is quickly becoming synonymous with diet, and therefore synonymous with health as well. We will try to answer five different questions in our discussion. Let's start with the first one. Why do you think people consume fast foods?
02.42	Joe and Claudia assume the following SIGs at the same time for 3 seconds:	
Joe	1 raise hand	
Claudia	1 raise hand	

People who have just gestured assume the following SIGs until otherwise is asked:

Joe	4 hand on desk	
Claudia 02.45	4 hand on desk	People consume fast food the most at lunch and basically at work. I think people would rather have the rapid service and convenience offered by the fast food industry: 'food on the run', in which within minutes you can have a wholesome meal. For the most, It is really a hassle for people to prepare a lunch and carry it to work. It is easier to buy a quick lunch.

While Claudia finishes talking, Joe proceeds and assume the following SIGs:

Joe 03.15	3 rolling hand	I would like to expand the comment about the rapid service around the fast food concept. In my opinion, it seems to me that Americans buy fast food because they feel that their time is worth more than their money. Business people don't have the time to sit down to a nice restaurant meal, nor do they have time to prepare a homemade meal in the morning and on a daily basis.

Once finished, Joe assumes the following SIGs:

Joe	4 hand on desk	
Sudeshna 03.45	NO SIGs	I think people consume fast foods because the media is always advertising this type of food. The graphics of meals are tempting and messages seduce people to consume this affordable and satisfactory fast food. Moreover, the design of the packaging favors the convenience of accessing and carrying the food on the run by the drive-through concept.

Haig asks second question for participation.

Haig 04.15	NO SIGs	We have advanced possible answers of why people consume fast foods. From your perspective: What types of fast foods do Americans have access to?

Heather assumes the following SIGs:

Heather 04.29	1 raise hand	
Dan 04.32	NO SIGs	There are many options. The primary one is McDonalds because it was the first one to introduce the fast food concept to the market along with the drive-through. The goal is to have a meal within a minute or two. Other fast food brands include Wendy's, Burger King, Taco Bell,

		Bojangles, etc. These chains offer standardized food "packages", as opposed to places such as Subway in which you have more of an option of that let you choose the toppings. Therefore, they have options for healthier fast food choices than burgers or fries. Nowadays Wendy's and others are developing a new wave of fast foods that include the delivery of salads.
Heather 05.20	4 hands on desk	I agree that there are many options, but I am not sure about how many 'healthy' options exist other than Wendy's salads. Especially when thinking about children, there aren't many appetizing options available in the market for a broader audience. All parents know the challenge of providing nutritious fast foods for their children. We are often tempted by the convenience of packaged food, but we know children are better served by wholesome meals. Children seem to like shapes in food such the alphabet pasta or the fruit rollup; a playful approach in food. McDonalds's 'happy meal' is very attractive to children by mixing food with play as mentioned, but not nutritious. Designers should work within this industry to use design for more and healthier fast food choices for children.
	Once finished, Heather assumes the following SIGs:	
Heather	2 leaning cheek on hand	
Sean 06.18	NO SIGs	I think the reason that fast food joints use few options and standardized 'packages' for their offered meals is because allows a much more efficiency in the fast food process when expanding the business globally. The components of each of the choices needs to be sustainable food that can be computerized and reproduced with the same quality anywhere in the world to keep costs down and make such expansion possible, without compromising the economic value of the meal for the consumer. In these terms, fast food choices are pretty much the same model across brands offering the same type of food: a standard cheeseburger, a quarter pound burger, chicken nuggets, French fries, etc.
	Haig asks third question for participation.	
Haig 07.12	NO SIGs	From this point, What do you think are the choices for healthier fast food meals?
07.20	Joe and Heather assume the following SIGs at the same time for 3 seconds:	
Heather	1 raise hand	
Joe	1 raise hand	

People who have just gestured assume the following SIGs until otherwise is asked:

Joe	4 hands on desk	
Heather 07.24	2 leaning cheek on hand	In answering this question we should first discuss the meaning of 'healthy meals', what is meant by healthy. People get confused when thinking eating healthy and being on a diet. For a majority of people, eating healthy is synonymous of being on a diet by having only a wide variety of vegetables and fat-free meats and dairy products. However, today's Atkins diet offers a contrasting concept to this idea. People under the Atkins' concept are basing their diets on the opposite of old-fashioned concept of diets: fat is free. You eat fat to burn fat but counting the grams of carbs in taken.
Sean 08.13	NO SIGs	There are many companies advertising 'healthy' fast foods. But, as we have said, 'healthy' has a new meaning to our society. From the introduction of the Atkins approach, many food chains are changing their slogans. For example, Taco bell advertises at the end of each of their commercials 'think outside the bun'. Companies are renovating their advertising and adapting to an emergent contemporary nutritional approach. It seems that eating on the run is no longer disastrous to your health: instead of the 'lite' or 'low-fat' cheeseburger of the '80's, the new trend is the 'low-carb' cheeseburger. There are numerous websites that have been developed to provide information to the public in counting the grams of carbs in each of the fast food choices in the market.

Joe assumes the following SIGs:

Joe 09.10	3 rolling hand	Certainly, there is a new economy developing around healthy fast foods. Nowadays, nearly every fast-food company in the country is trying to attract customers who want to lose weight based on the Atkins' approach. They have labeled the new industry as "Atkins friendly' menus. The fast food industry is taking advantage of the current fashionable nutritious plan. The fast-food 'diet' menu includes bacon cheeseburgers without the bun. They replace the bun with lettuce. After decades of promoting super sized burgers, fries and sodas, companies such as McDonald's and Subway have gone further than adding menu items to create images as obesity fighters based on their products.

Once finished, Joe assumes the following SIGs:

Joe	4 hands on desk	
	Haig asks forth question for participation.	
Haig 10.00	NO SIGs	Does everyone agree with the statement that American fast foods could be a healthy choice?
10.07	People who gesture assume the following SIGs at the same time for 3 seconds:	
Heather	1 raise hand	
Joe	1 raise hand	
10.10	All participants engage in verbal interaction. Heather and Joe keep holding SIGs in same position at all times.	
Sean 10.10	NO SIGs	I don't agree.
Sudeshna 10.13	NO SIGs	I don't agree.
Dan 10.16	NO SIGs	I agree.
Joe 10.19	1 raise hand	I agree.
Claudia 10.22	4 hand on desk	I don't agree.
Heather 10.25	1 raise hand	I agree.
10.27	People who have just gestured assume the following SIGs until otherwise is asked:	
Joe	4 hands on desk	
Heather	2 leaning cheek on hand	
Claudia	4 hand on desk	
10.28	Haig asks last question for participation.	
Haig	NO SIGs	In the event we agree to the question of considering fast food as healthy choice… How good/bad is consuming current fast foods on one's health?
	Claudia assumes the following SIGs:	
Claudia 10.40	1 raise hand	
	While Sudeshna starts talking, Claudia assumes the following SIGs:	
Claudia	4 hand on desk	
Sudeshna 10.44	NO SIGs	It is difficult to consider current fast foods as a healthy choice. The problem lies in that ready-made meals are not fresh and loaded in fat and calories. Even if you take away the bun, basically, you can eat as much bacon; cheese

		and meats as you want while limiting the fruits and vegetables that potentially contain natural sugars. According to my knowledge, after an extended period of infusing Atkins' style healthier fast food choices people feel weak and lethargic. Glucose is the body's preferred source of fuel because it burns fast. Atkins sets up an alternative metabolic pathway for producing energy: You switch from a primarily glucose metabolism to a fat metabolism. I cannot see a healthier choice by rejecting natural processes.
Dan 11.43	NO SIGs	Currently, research studies indicate surprising numbers of people who eat fast food everyday creating the habit of excess in calories regardless of what diet model. How good/bad is consuming current fast foods on one's health is directly dependent of the current physical health level of each individual consumer. While it might be positive that current fast foods could be a healthier choice, this type of diet is closely related to the level of physical activity performed by each individual. The fast food industry should not only adapt to trendy diets but also educate the public in exercising. A good strategy has been introduced by McDonald's with Adult Happy Meals. They will be available in the market soon. The adult happy meal box contains a salad; bottled water and a pedometer that helps users count steps. In this regard, current fast food could be good for one's health.
Claudia 12.48	4 hands on desk	The strategy of the fast food industry in the advertising of physical activities could not be efficient approach in helping American society's fight against obesity. It is like they want people to believe that if they exercise, they can eat the other stuff. In reality, you would need to run 9 miles in one hour to burn off one Whopper. It is known that fast foods are very dense in calories, such that you only need a small amount to bump up your calorific intake. These "energy dense" foods can fool people into consuming more calories than the body needs, thus increasing a person's risk of weight gain and obesity. People tend to assess food intake by the size of the portion, rather than the ingredients of the food. They may feel that they are eating no more than they would if they ate an average meal such as substituting a salad for a burger doesn't guarantee fewer calories and less fat. Dressing can contain more fat and calories than a double cheeseburger.
	Haig draws the conclusion	
Haig 13.57	NO SIGs	It seems that the American society is more interested in quantity than quality. Many people are relating healthiness with the amount of calories taken. Having a calorie counter in your pocket could mean counting how

healthy you are on a daily basis. However, a diet is not synonymous with being healthy. To be healthy is not only to take into account the type and amount of food inhaled, but also how one's body is engaged in physical activities. The conclusion in the topic of the relationship between American Fast Food and Health with a multidisciplinary focus is that he industry can help and lead the consumer to healthier choices. But it is up to the citizen strength to contribute to a better balance of mind, soul and body after all.

Thank you very much for today's class.

14.57 SIGs people assume neutral position. The body is straight and hands are resting on legs.
Haig thanks the class.

Dissertation in Design Research Study

The purpose of my study is to **understand communication structures** in the context of distance education.

I would like you to **complete a survey**, based on a movie/video I will show you of a distance education class. Your participation requires about 20 minutes including the activities of watching the video and completing the survey.

Your **participation** in this study is **voluntary**, where no compensation will be given to you. No risks are involved. If you decide to participate, you may withdraw from the study at any time by closing the browser window. If you withdraw from the study before data collection is completed your data will be automatically destroyed.

I will not ask for your name at any point of your participation, so as to protect your confidentiality on information that you will be providing me.
The information in the study records will be kept strictly confidential.
No reference will be made in oral or written reports which could link you to the study.

If you have any questions, regarding you participation,
please contact me at 919.389.2302 or cbrebola@ncsu.edu.
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Dr. Matthew Zingraff, Chair of the NCSU IRB for the Use of Human Subjects in Research Committee, Box 7514, NCSU Campus (919/513-1834) or Mr. Matthew Ronning, Assistant Vice Chancellor, Research Administration, Box 7514, NCSU Campus (919/513-2148).

Thank you for your participation in my dissertation research project.

Claudia Rebola Winegarden
PhD Candidate

NEXT

Consent Form

I have read and understand the above information.
If I agree to receive a copy of this form, please send it via the following e-mail:

I agree to participate in this study with the understanding that I may withdraw at any time.

October 01 of 2004.

Consent

Do you agree to participate in this study?

- ○ **Yes**
- ○ **No**

Directions

There are **no right or wrong** choices,
simply **do your best** in answering each question
with your **own personal judgment.**

There are a total of **eight sections**:

In the **first** section, I will ask you some background information.

In the **second** section, I will show you a video, on which you will base your answers.

In the **third through** the **eight** section, I will ask you questions
about your perceptions of student participation under different conditions.
The survey questions are not based on the topic-content discuss on the video.
You will need to **Check-off** or **write** your answer, when asked,
in the assigned space below each question.

Let's practice with the following question:

Are you student at NC State University?
- ○ **Yes**
- ○ **No**

Very important:
After completing each section, you will need to click NEXT.
Once you have completed all sections, you will need to **SUBMIT** your survey.
Let's practice clicking on 'next' at the bottom right corner of this page to start the survey.

NEXT

Section One

Tell me about yourself

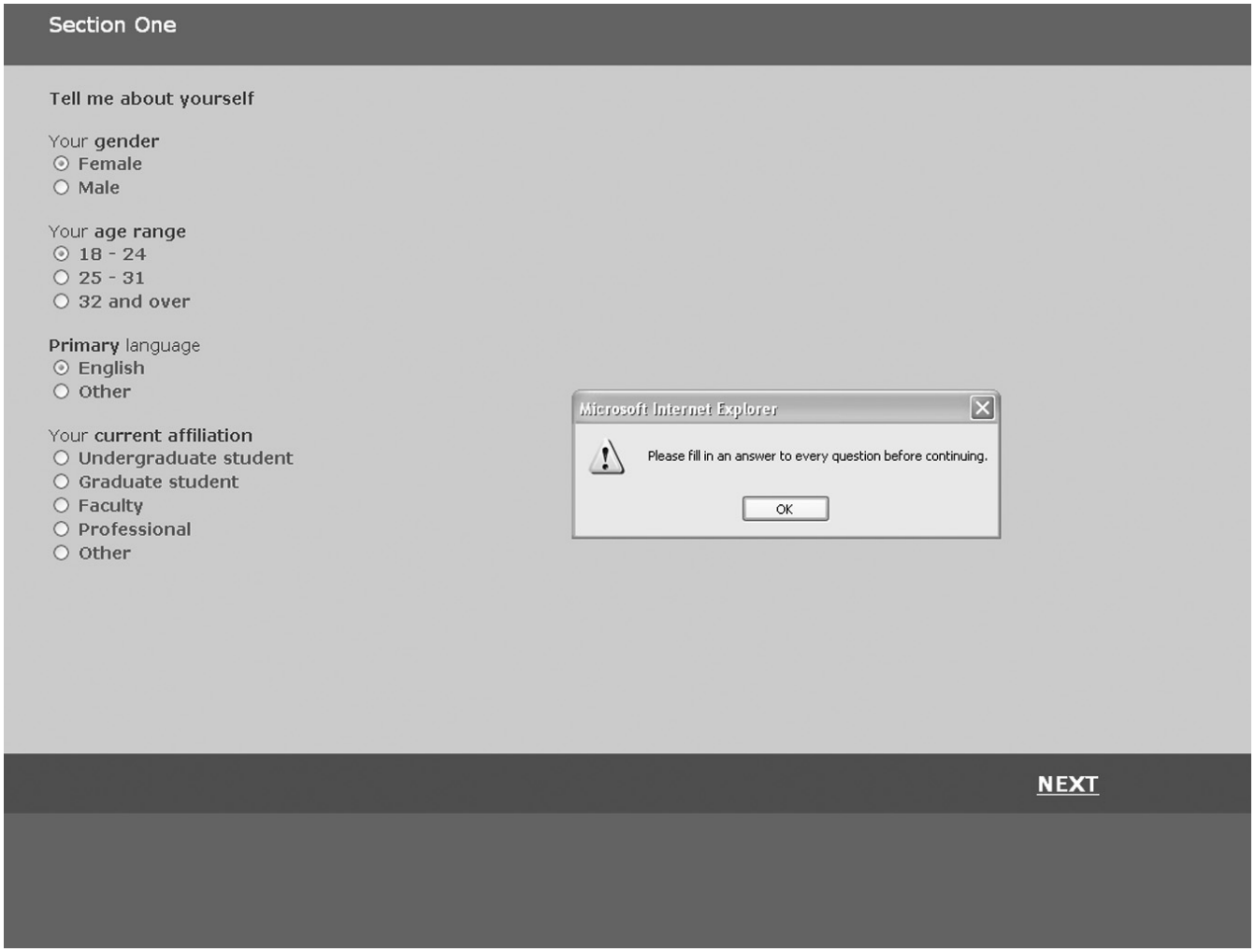
Your **gender**
- ○ Female
- ○ Male

Your **age range**
- ○ 18 - 24
- ○ 25 - 31
- ○ 32 and over

Primary language
- ○ English
- ○ Other

Your **current affiliation**
- ○ Undergraduate student
- ○ Graduate student
- ○ Faculty
- ○ Professional
- ○ Other

NEXT


Section One
Tell me about yourself
Your gender
Female
Male
Your age range
18 - 24
25 - 31
32 and over
Primary language
English
Other
Your current affiliation
Undergraduate student
Graduate student
Faculty
Professional
Other
Microsoft Internet Explorer
Please fill in an answer to every question before continuing.
OK
NEXT

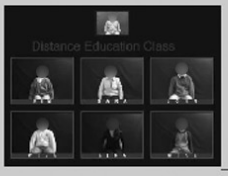
Section Two

Have **you** ever **participated** in a **videoconferencing**/distance education class?

- ○ No
- ○ **Yes. How many times?** once

If you have received this **survey via e-mail**, please **follow the instructions below.**
Otherwise, **proceed to click 'play' and watch the movie that is open in QuickTime outside this window.** DON'T CLOSE THIS WINDOW AT ANY POINT.

Instructions to watch the movie for surveys via e-mail
First of all, **DON'T CLOSE THIS WINDOW AT ANY POINT.**
Second, click on the **movie file** below. A pop-up window will ask you if you want to open or save the file.
Third, Click on 'Open'. This takes a little time to download, please be patient.
Once the download is complete, QuickTime will open the file.
Fourth, Proceed to watch the movie by **clicking on the 'play' button.**
The movie is 13:40 minutes long. Please, don't interrupt the play.
I can verify if you have **watched the entire movie**.
In the event you have answered the survey questionnaire without having watched the entire movie, I will need to discard your participation.
Fifth, once have you finished watching the video, please return to this survey.
After watching the movie, **don't forget to click next** in this window to continue the survey.



Movie file

NEXT

Section Three

In your assessment, **rate from 1 to 6** the diagram below of the student's name or the window position of that student, who participated, according to the following statements:

Kim Sara John

Will Lisa Mike

PLEASE SELECT EACH RANKING ONLY ONCE!

In this study, participation is defined as how the student gets involved during the course of the class.
There are a total of 6 people as well as 6 statements and 6 numbers..
Only use each number once for only one person.
I .e. if you think the person who participated most is John, assign 1 to John. Nobody else will be able to have 1.

- 1 Student who **participated the most**
- 2 Student who **participated second most**
- 3 She student who **participated third most**
- 4 Student who **participated fourth most**
- 5 Student who **participated more than the least**
- 6 Student who **participated the least**

In your own words, please give me a **brief description** of your reason for choosing, based on the following statements:

Student who participated the most

Student who participated the least

NEXT

Section Four

In your assessment, **how did students call for attention** in the online classroom environment?

- ○ **Just talking**
- ○ **Raising hand**
- ○ **Combination of both**

Please **check-mark** the student's name **who raised their hand** during the online class:

Kim ☐ **Sara** ☐ **John** ☐

Will ☐ **Lisa** ☐ **Mike** ☐

In your own words, please give me a **brief explanation** of **how you recognized this student(s)** and what caused you to make this judgment.

If you were participating in that online class, which **type of interaction would be your choice for calling for attention**?

- ○ **Just talking**
- ○ **Raising your hand**
- ○ **Combination of both**

NEXT

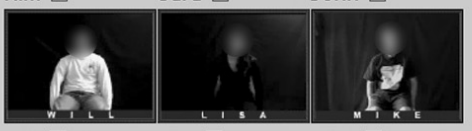
Section Five

In your assessment, **how did students avoid attention** in the online classroom environment?

- ○ **Just not talking**
- ○ **Crossing hands**
- ○ **Combination of both**

Please **check-mark** the student's name or window position, **who crossed their hands** during the online class:

Kim ☐ **Sara** ☐ **John** ☐



Will ☐ **Lisa** ☐ **Mike** ☐

In your own words, please give me a **brief explanation of how you recognized this student(s)** and what caused you to make this judgment.

If you were participating in that online class, which **type of interaction would be your choice for avoiding attention**?

- ○ **Just not talking**
- ○ **Crossing hands**
- ○ **Combination of both**

NEXT

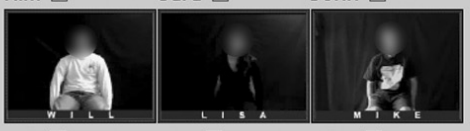
Section Six

In your assessment, **how did students show their uncertainty** in the online classroom environment?

- ○ **Just not talking**
- ○ **Using their hand on their chin**
- ○ **Combination of both**

Please **check-mark** the student's name or window position, **who used their hand on the chin** during the online class:

Kim ☐ **Sara** ☐ **John** ☐



Will ☐ **Lisa** ☐ **Mike** ☐

In your own words, please give me a **brief explanation of how you recognized this student(s)** and what caused you to make this judgment.

If you were participating in that online class, which **type of interaction would be your choice for showing uncertainty**?

- ○ **Just not talking**
- ○ **Using your hand on your chin**
- ○ **Combination of both**

NEXT

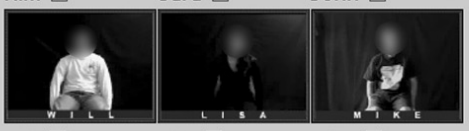
Section Seven

In your assessment, **how did students** show positive feedback agreement in the online classroom environment?

- ○ **Just saying 'I agree'**
- ○ **Raising their hand**
- ○ **Combination of both**

Please **check-mark** the student's name or window position, **who raised their hand when agreeing** during the online class:

Kim ☐ **Sara** ☐ **John** ☐



Will ☐ **Lisa** ☐ **Mike** ☐

In your own words, please give me a **brief explanation of how you recognized this student(s)** and what caused you to make this judgment.

If you were participating in that online class, which **type of interaction would be your choice for showing positive feedback**?

- ○ **Just saying 'I agree'**
- ○ **Raising your hand**
- ○ **Combination of both**

NEXT

Section Eight

From your observations, **were you aware of students using hand gestures** during the online class?

- ○ No
- ○ **Somewhat**
- ○ **Yes**

How many hand gestures do you think the students did overall?

- ○ **Around 5 - not many**
- ○ **Around 15 - many**
- ○ **Around 40 - very many**

From your perspective, do you think it **is efficient to use hand gestures in online environments**?

- ○ No
- ○ **Yes. Why?**

Do you think there are any **other relevant techniques or mechanisms** to make online videoconferencing environments **more interactive**?

- ○ No
- ○ **Yes. Explain**

NEXT

Section Eight

At your assessment, what do you think the following visuals communicated during class?
Please **place a number which statement correspond to the visual:**

red border - **dotted red border** - **numbers** - **half opacity** -

1) A student disengaged and **avoiding attention** during class
2) A student talking and **actively participating** during class
3) A student asking to talk and **calling for attention** during class
4) An student doubtful and **showing uncertainty** during class

From your observations, **were you aware of students giving visual cues** during the online class?
- No
- **Somewhat**
- **Yes**

How many visual cues do you think the students did overall?
- **Around 5 - not many**
- **Around 15 - many**
- **Around 40 - very many**

From your perspective, do you think it **is efficient to use visual cues in online environments**?
- No
- **Yes. Why?**

Do you think there are any **other relevant techniques or mechanisms** to make online videoconferencing environments **more interactive**?
- No
- **Yes. Explain**

NEXT

Thanks!

Thank you for taking the time to answer these questions.
The results will be collected, analyzed and presented in my doctoral dissertation on February 2005.
Please contact me, if you would like me to share the results with you after January 2005.

Submit

No problem!

Please contact me at **919.389.2302** or cbrebola@ncsu.edu
if you would like to participate in another opportunity.

Thank you!

Appendix C

Delivery Channel Totals

Statistic (%)	*Behavior*	Gesture-Only	Verbal-Only	Gesture+Verbal	DC N/A	total
Local Students						
Total duration (% of observation)	S	44.90	0.52	3.34	51.25	100
Total duration (% of subjects direct observation)		**92.10**	1.06	6.85	-	100
Remote Students						
Total duration (% of observation)	R	24.84	0.00	1.18	73.99	100
Total duration (% of subjects direct observation)		**95.48**	0.00	4.52	-	100
Totals		34.87	0.26	2.26	62.62	100
		93.79	0.53	5.68	-	

Gesture Action Totals

Statistic (%)	raise h	cross arms	roll h	h in chin	h in mouth	leaning on h	hiding h	physical	h behind head	hand movement	instrumental	neutral	pointing	cross fingers	other action	A N/A	total
Local Students																	
Total duration (% of observation)	0.05	2.20	1.69	3.53	3.29	5.85	1.03	2.91	0.02	3.17	11.78	11.93	0.07	1.11	0.07	51.29	100
Total duration (% of subjects direct observation)	0.10	4.51	3.47	7.25	6.75	**12.02**	2.12	5.98	0.04	6.50	**24.19**	**24.50**	0.14	2.28	0.14	-	100
Remote Students																	
Total duration (% of observation)	0.00	0.38	0.74	0.27	0.76	1.98	0.27	1.45	0.00	4.53	6.26	9.35	0.00	0.00	0.00	74.03	100
Total duration (% of subjects direct observation)	0.00	1.46	2.85	1.04	2.91	**7.62**	1.02	5.58	0.00	17.44	**24.08**	**35.98**	0.00	0.00	0.00	-	100
Totals	0.03	1.29	1.21	1.90	2.02	3.92	0.65	2.18	0.01	3.85	9.02	10.64	0.04	0.56	0.03	62.66	100
	0.05	2.99	3.16	4.15	4.83	**9.82**	1.57	5.78	0.02	11.97	**24.14**	**30.24**	0.07	1.14	0.07	-	

Gesture Direction Totals

Statistic (%)	oneself/none	a person	group	something	D N/A	total
Local Students						
Total duration (% of observation)	45.87	1.60	0.99	0.16	51.39	100
Total duration (% of subjects direct observation)	**94.36**	3.29	2.03	0.33	-	100
Remote Students						
Total duration (% of observation)	24.82	0.00	0.79	0.38	74.03	100
Total duration (% of subjects direct observation)	**95.52**	0.00	3.04	1.44	-	100
Totals	35.34	0.80	0.89	0.27	62.71	100
	94.94	1.64	2.53	0.88	-	

Space and Hand Used Totals

Statistic (%)	1 h Low	2 h Low	1 h Middle	2 h Middle	1 h Upper	2 h Upper	H N/A	total
Local Students								
Total duration (% of observation)	9.07	21.81	14.32	3.21	0.23	0.07	51.30	100
Total duration (% of subjects direct observation)	18.61	**44.78**	**29.40**	6.58	0.47	0.15	-	100
Remote Students								
Total duration (% of observation)	3.87	18.02	4.02	0.04	0.04	0.00	74.03	100
Total duration (% of subjects direct observation)	14.88	**69.35**	**15.47**	0.15	0.15	0.00	-	100
Totals	6.47	19.91	9.17	1.62	0.14	0.04	62.66	100
	16.75	**57.06**	**22.44**	3.37	0.31	0.08	-	

Emotional State Totals

Statistic (%)	neutral/calm	anxious	confident	insecure	interested	bored/tired	positive	negative	other emotion 1	E N/A	total
Local Students											
Total duration (% of observation)	8.90	1.76	1.44	0.56	26.00	9.67	0.33	0.01	0.02	51.30	100
Total duration (% of subjects direct observation)	18.28	3.61	2.96	1.15	**53.39**	**19.85**	0.68	0.02	0.05	-	100
Remote Students											
Total duration (% of observation)	1.17	1.80	0.02	0.30	16.10	6.25	0.33	0.00	0.02	74.03	100
Total duration (% of subjects direct observation)	4.51	6.93	0.06	1.14	**61.98**	**24.05**	1.25	0.00	0.08	-	100
Totals	5.04	1.78	0.73	0.43	21.05	7.96	0.33	0.00	0.02	62.66	100
	11.39	5.27	1.51	1.14	**57.69**	**21.95**	0.96	0.01	0.06	-	

Posture Totals

Statistic (%)	straight	leaning front	leaning back	P N/A	total	
Local Students						
Total duration (% of observation)	15.81	15.89	17.01	51.29	100	
Total duration (% of subjects direct observation)	32.46	32.62	**34.91**	-	100	48.71
Remote Students						
Total duration (% of observation)	12.51	9.64	3.83	74.03	100	
Total duration (% of subjects direct observation)	**48.16**	37.09	14.74	-	100	25.98
Totals	14.16	12.76	10.42	62.66	100	
	40.31	34.86	24.83	-		

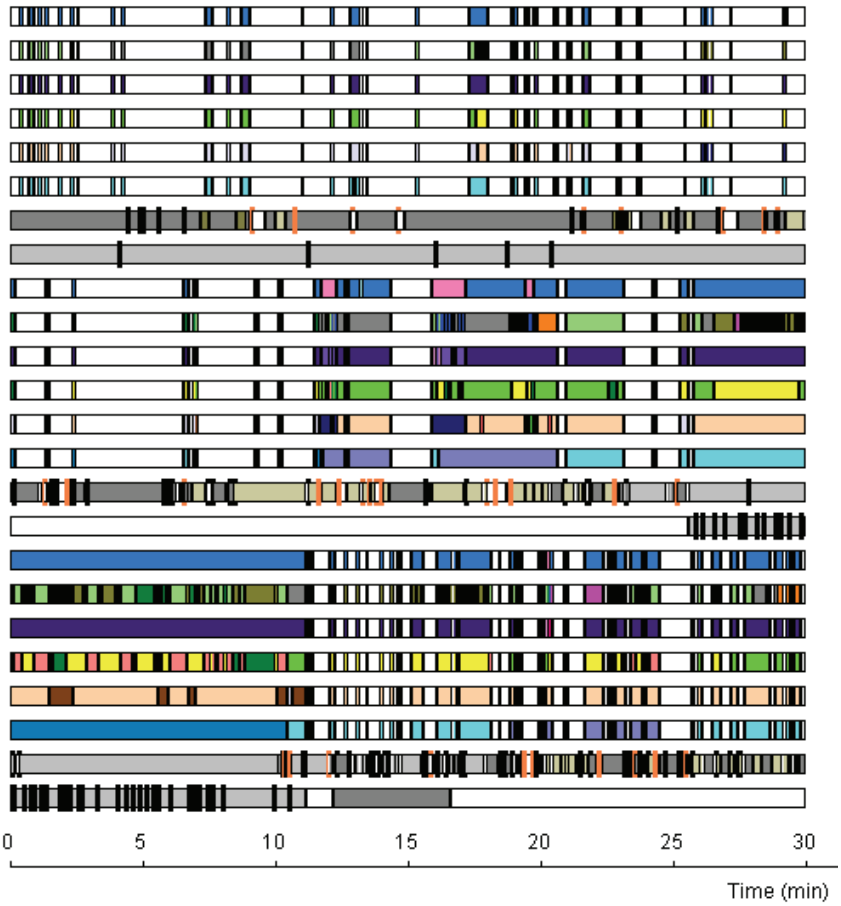
Legend	
Behavior	Color/Pattern
N/A	
Delivery Channel	
Gesture+Verbal	
Gesture-Only	
Verbal-Only	
SIGs Action	
cross arms	
h behind head	
h in chin	
h in mouth	
hand movement	
hiding h	
instrumental	
leaning on h	
neutral	

Legend	
Behavior	Color/Pattern
other action 1	
other action 2	
other action 3	
physical	
raise h	
roll h	
SIGs Direction	
a person	
group	
oneself/none	
something	
SIGs Hands Used	
1 h Low	
1 h Middle	
1 h Upper	

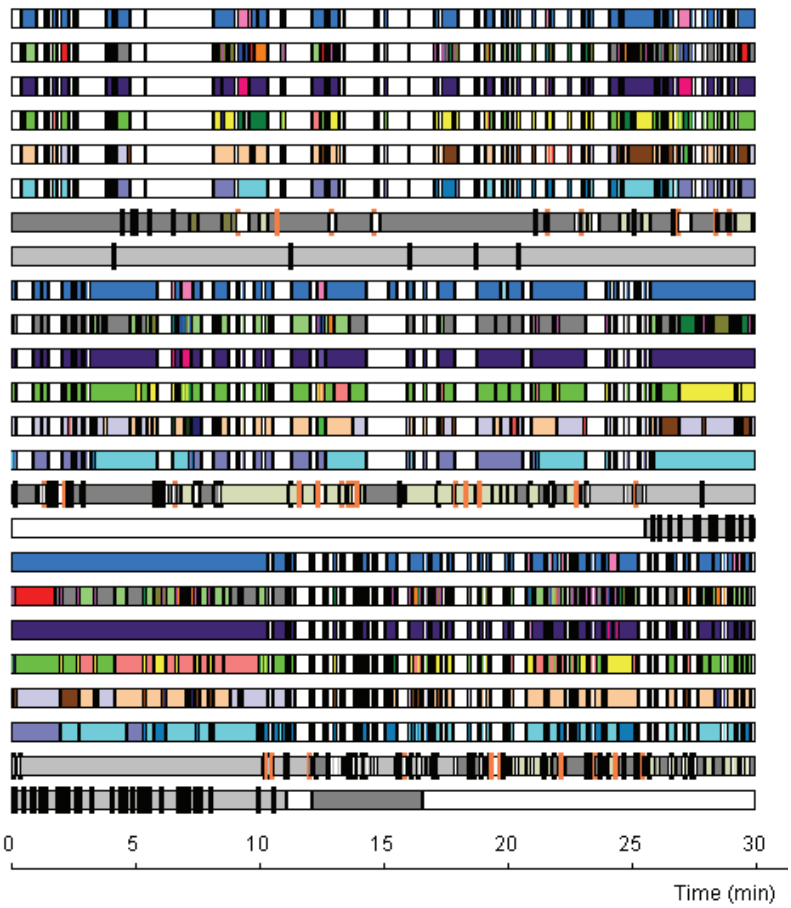
Legend	
Behavior	Color/Pattern
2 h Low	
2 h Middle	
2 h Upper	
Subject Emotional S	
anxious	
bored/tired	
confident	
insecure	
interested	
negative	
neutral/calm	
other emotion 1	
positive	
Subject Posture	
leaning back	

Legend	
Behavior	Color/Pattern
leaning front	
straight	
Intervention	
o ask question	
p ask question	
p lecture	
p r lecture	
s ask question	
s lecture	
Media	
Elmo	
change	
ppt	

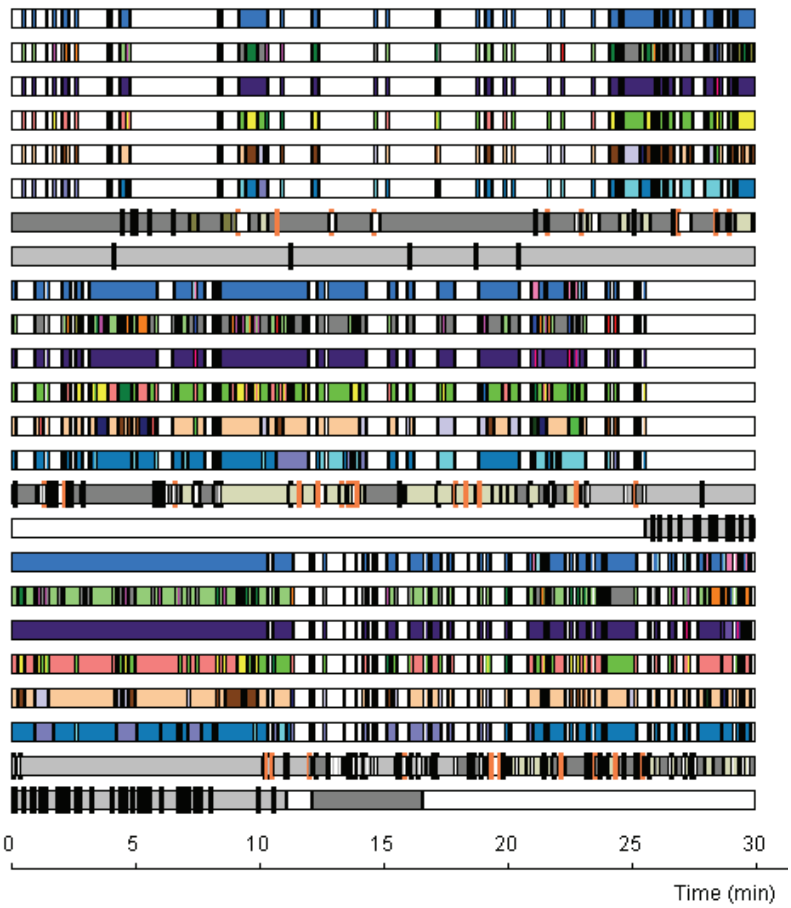
Observation	Behavioral Class
S11	Delivery Channel
S11	SIGs Action
S11	SIGs Direction
S11	SIGs Hands Used
S11	SIGs Emotional S
S11	Subject Posture
S11	Intervetion
S11	Media
S12	Delivery Channel
S12	SIGs Action
S12	SIGs Direction
S12	SIGs Hands Used
S12	SIGs Emotional S
S12	Subject Posture
S12	Intervetion
S12	Media
S13	Delivery Channel
S13	SIGs Action
S13	SIGs Direction
S13	SIGs Hands Used
S13	SIGs Emotional S
S13	Subject Posture
S13	Intervetion
S13	Media



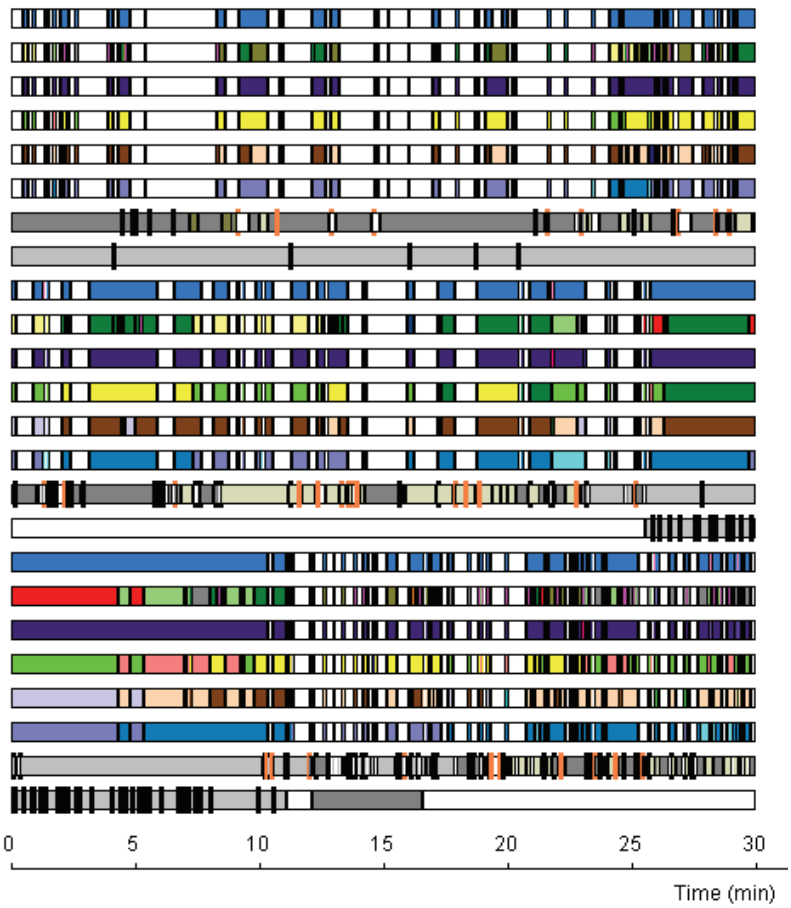
Observation	Behavioral Class
S21	Delivery Channel
S21	SIGs Action
S21	SIGs Direction
S21	SIGs Hands Used
S21	SIGs Emotional S
S21	Subject Posture
S21	Intervetion
S21	Media
S22	Delivery Channel
S22	SIGs Action
S22	SIGs Direction
S22	SIGs Hands Used
S22	SIGs Emotional S
S22	Subject Posture
S22	Intervetion
S22	Media
S23	Delivery Channel
S23	SIGs Action
S23	SIGs Direction
S23	SIGs Hands Used
S23	SIGs Emotional S
S23	Subject Posture
S23	Intervetion
S23	Media



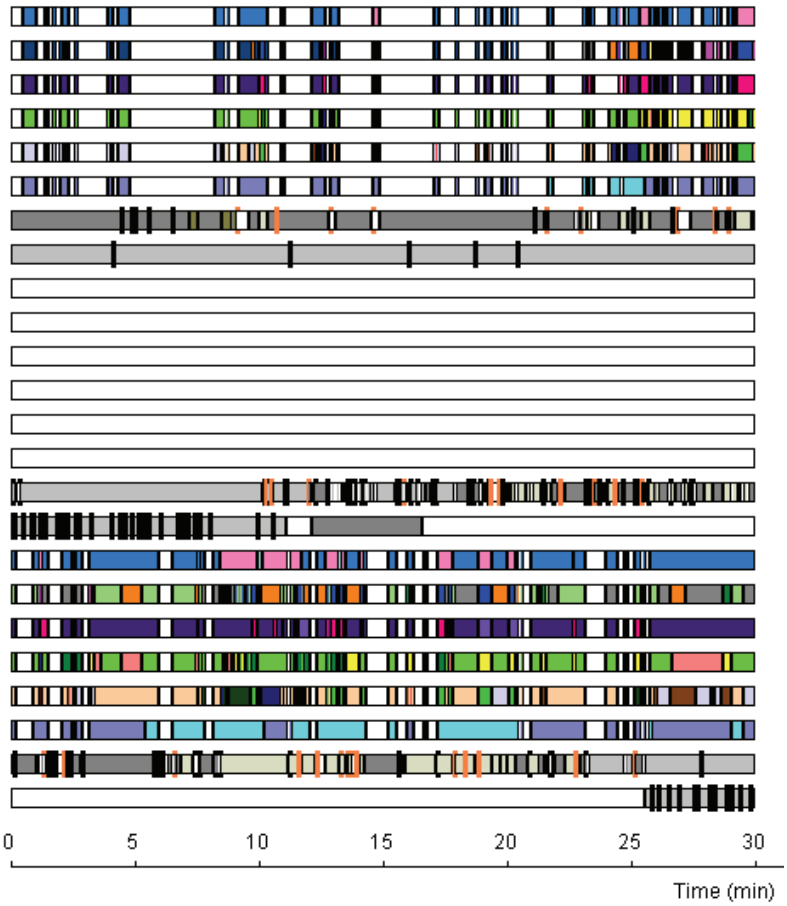
Observation	Behavioral Class
S31	Delivery Channel
S31	SIGs Action
S31	SIGs Direction
S31	SIGs Hands Used
S31	SIGs Emotional S
S31	Subject Posture
S31	Intervetion
S31	Media
S32	Delivery Channel
S32	SIGs Action
S32	SIGs Direction
S32	SIGs Hands Used
S32	SIGs Emotional S
S32	Subject Posture
S32	Intervetion
S32	Media
S33	Delivery Channel
S33	SIGs Action
S33	SIGs Direction
S33	SIGs Hands Used
S33	SIGs Emotional S
S33	Subject Posture
S33	Intervetion
S33	Media



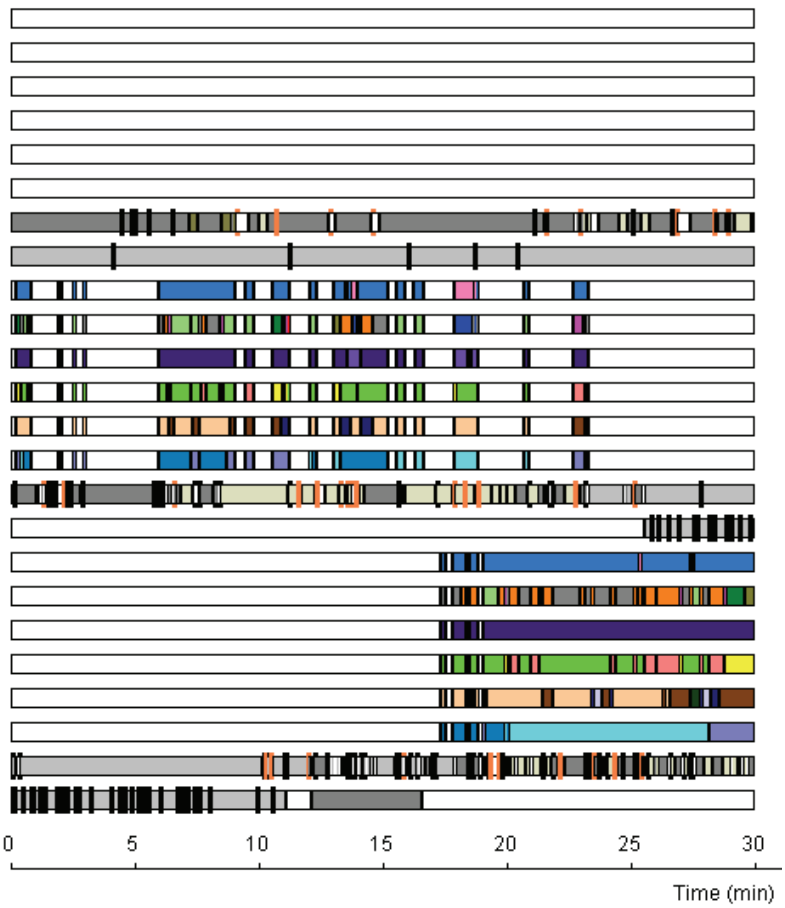
Observation	Behavioral Class
S41	Delivery Channel
S41	SIGs Action
S41	SIGs Direction
S41	SIGs Hands Used
S41	SIGs Emotional S
S41	Subject Posture
S41	Intervetion
S41	Media
S42	Delivery Channel
S42	SIGs Action
S42	SIGs Direction
S42	SIGs Hands Used
S42	SIGs Emotional S
S42	Subject Posture
S42	Intervetion
S42	Media
S43	Delivery Channel
S43	SIGs Action
S43	SIGs Direction
S43	SIGs Hands Used
S43	SIGs Emotional S
S43	Subject Posture
S43	Intervetion
S43	Media



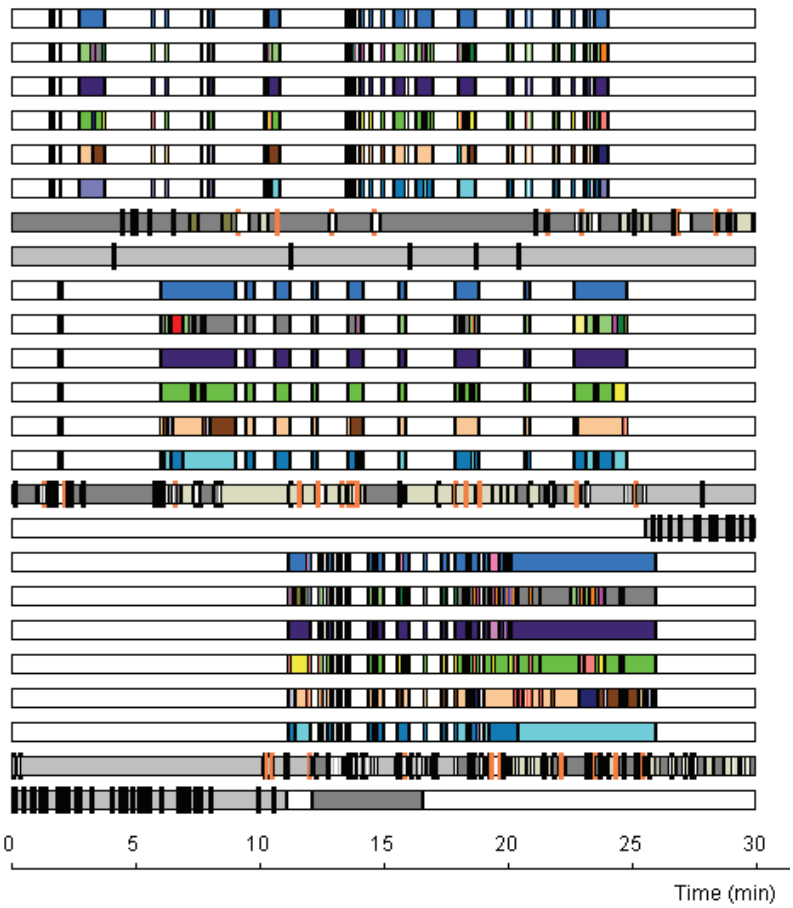
Observation	Behavioral Class
S61	Delivery Channel
S61	SIGs Action
S61	SIGs Direction
S61	SIGs Hands Used
S61	SIGs Emotional S
S61	Subject Posture
S61	Intervetion
S61	Media
S63	Delivery Channel
S63	SIGs Action
S63	SIGs Direction
S63	SIGs Hands Used
S63	SIGs Emotional S
S63	Subject Posture
S63	Intervetion
S63	Media
S62	Delivery Channel
S62	SIGs Action
S62	SIGs Direction
S62	SIGs Hands Used
S62	SIGs Emotional S
S62	Subject Posture
S62	Intervetion
S62	Media



Observation	Behavioral Class
R11	Delivery Channel
R11	SIGs Action
R11	SIGs Direction
R11	SIGs Hands Used
R11	SIGs Emotional S
R11	Subject Posture
R11	Intervetion
R11	Media
R12	Delivery Channel
R12	SIGs Action
R12	SIGs Direction
R12	SIGs Hands Used
R12	SIGs Emotional S
R12	Subject Posture
R12	Intervetion
R12	Media
R13	Delivery Channel
R13	SIGs Action
R13	SIGs Direction
R13	SIGs Hands Used
R13	SIGs Emotional S
R13	Subject Posture
R13	Intervetion
R13	Media



Observation	Behavioral Class
R21	Delivery Channel
R21	SIGs Action
R21	SIGs Direction
R21	SIGs Hands Used
R21	SIGs Emotional S
R21	Subject Posture
R21	Intervetion
R21	Media
R22	Delivery Channel
R22	SIGs Action
R22	SIGs Direction
R22	SIGs Hands Used
R22	SIGs Emotional S
R22	Subject Posture
R22	Intervetion
R22	Media
R23	Delivery Channel
R23	SIGs Action
R23	SIGs Direction
R23	SIGs Hands Used
R23	SIGs Emotional S
R23	Subject Posture
R23	Intervetion
R23	Media



S1 Group	Delivery Channel				Gesture Action							
Statistic *Behavior*	Gesture-Only	Verbal-Only	Gesture+Verbal	DC N/A	raise h	cross arms	roll h	h in chin	h in mouth	leaning on h	hiding h	physical
Total number	83	1	4	80	-	-	15	33	29	18	-	9
Rate (number per minute)	0.92	0.01	0.04	0.89	-	-	0.17	0.37	0.32	0.2	-	0.1
Total duration (s)	2188.91	2.43	143.37	3065.38	-	-	59.1	467.87	318.77	173.61	-	84.12
Total duration (% of observation)	**40.53**	0.04	2.65	56.77	-	-	1.09	8.66	5.9	3.21	-	1.56
Mean duration (s)	26.37	2.43	35.84	38.32	-	-	3.94	14.18	10.99	9.65	-	9.35
Minimum duration (s)	0.9	2.43	14.57	3.93	-	-	1.06	1.3	0.9	1.23	-	2.3
Maximum duration (s)	669.23	2.43	75.2	244.6	-	-	13.47	98.73	69.87	39.73	-	41.7
Standard deviation of duration (s)	79.66	-	27.74	42.01	-	-	4.19	18.72	15.6	8.7	-	12.72
Standard error of mean duration (s)	8.74	-	13.87	4.7	-	-	1.08	3.26	2.9	2.05	-	4.24
Median duration (s)	7.16	2.43	26.8	24.04	-	-	1.7	7.56	4.57	6.59	-	4.6
Confidence interval of duration (s)	23.36	-	44.13	12.55	-	-	2.32	8.71	5.93	4.33	-	9.78
Mean total of observations	27.67	0.33	1.33	26.67	-	-	5	11	9.67	6	-	3

S2 Group	Delivery Channel				Gesture Action							
Statistic *Behavior*	Gesture-Only	Verbal-Only	Gesture+Verbal	DC N/A	raise h	cross arms	roll h	h in chin	h in mouth	leaning on h	hiding h	physical
Total number	118	7	20	106	3	10	19	24	30	26	-	59
Rate (number per minute)	1.31	0.08	0.22	1.18	0.03	0.11	0.21	0.27	0.33	0.29	-	0.66
Total duration (s)	2969.39	49.2	184.47	2197.03	3.96	202.74	88.13	189.27	208.84	201.72	-	211.82
Total duration (% of observation)	54.99	0.91	3.42	40.69	0.07	3.75	1.63	3.5	3.87	3.74	-	3.92
Mean duration (s)	25.16	7.03	9.22	20.73	1.32	20.27	4.64	7.89	6.96	7.76	-	3.59
Minimum duration (s)	0.84	0.6	0.34	2.06	0.73	1.53	0.5	1.03	0.67	0.94	-	1
Maximum duration (s)	622.3	18.97	32.96	164.43	1.7	99.97	15.63	23.37	40.4	40.3	-	11.13
Standard deviation of duration (s)	64.04	6.03	11.18	21.5	0.52	28.9	4.76	6.7	7.98	7.69	-	2.18
Standard error of mean duration (s)	5.9	2.28	2.5	2.09	0.3	9.14	1.09	1.37	1.46	1.51	-	0.28
Median duration (s)	10.71	6.4	4.23	13.9	1.53	13.14	2.27	5.35	4.29	6.39	-	3.2
Confidence interval of duration (s)	15.75	5.58	5.23	5.58	1.29	20.67	2.29	2.83	2.98	3.11	-	0.76
Mean total of observations	39.33	2.33	6.67	35.33	1	3.33	6.33	8	10	8.67	-	19.67

S1 Group Cont.

								Gesture Direction					Hand(s) and Space Used				
h behind head	hand movement	instrumental	neutral	pointing	cross fingers	other action	A N/A	oneself/none	a person	group	something	D N/A	1 h Low	2 h Low	1 h Middle	2 h Middle	1 h Upper
-	6	50	34	-	-	-	80	80	1	7	7	80	22	55	60	10	-
-	0.07	0.56	0.38	-	-	-	0.89	0.89	0.01	0.08	0.08	0.89	0.24	0.61	0.67	0.11	-
-	95.77	659.67	470.45	-	-	-	3070.73	2202.32	11.1	86.79	28.81	3071.07	314.16	909.78	954.13	150.95	-
-	1.77	12.22	8.71	-	-	-	56.86	**40.78**	0.21	1.61	0.53	56.87	5.82	**16.85**	**17.67**	2.8	-
-	15.96	13.19	13.84	-	-	-	38.38	27.53	11.1	12.4	4.12	38.39	14.28	16.54	15.9	15.1	-
-	1.67	0.73	0.87	-	-	-	3.9	0.9	11.1	0.17	0.84	3.9	1.77	0.87	0.9	0.97	-
-	45.2	132.33	107.27	-	-	-	244.63	669.2	11.1	28.76	11.2	244.63	37.83	111.43	193.67	69.87	-
-	15.27	19.38	24.59	-	-	-	42.04	82.96	-	10.69	3.95	42.03	10.26	24.17	27.52	21.43	-
-	6.23	2.74	4.22	-	-	-	4.7	9.28	-	4.04	1.49	4.7	2.19	3.26	3.55	6.78	-
-	13.05	7.43	4.42	-	-	-	24.04	7.04	11.1	12.24	1.54	24.04	12.37	8.8	6.69	8.29	-
-	16.03	7.32	11.27	-	-	-	12.56	24.78	-	9.89	3.65	12.56	4.55	8.71	9.49	15.33	-
-	2	16.67	11.33	-	-	-	26.67	26.67	0.33	2.33	2.33	26.67	7.33	18.33	20	3.33	-

S2 Group Cont.

								Gesture Direction					Hand(s) and Space Used				
h behind head	hand movement	instrumental	neutral	pointing	cross fingers	other action	A N/A	oneself/none	a person	group	something	D N/A	1 h Low	2 h Low	1 h Middle	2 h Middle	1 h Upper
1	18	63	96	6	2	-	104	115	14	1	4	104	42	117	73	11	5
0.01	0.2	0.7	1.07	0.07	0.02	-	1.16	1.28	0.16	0.01	0.04	1.16	0.47	1.3	0.81	0.12	0.06
5.3	151.17	716.07	1173.58	17.94	4.06	-	2225.49	3004.8	135.89	21.07	12.84	2225.49	539.99	1665.58	794.16	139.01	19.56
0.1	2.8	13.26	21.73	0.33	0.08	-	41.21	55.64	2.52	0.39	0.24	41.21	10	30.84	14.71	2.57	0.36
5.3	8.4	11.37	12.22	2.99	2.03	-	21.4	26.13	9.71	21.07	3.21	21.4	12.86	14.24	10.88	12.64	3.91
5.3	0.9	0.84	0.37	0.97	1.43	-	1.8	0.87	0.6	21.07	1.33	1.8	1.23	0.43	0.73	0.97	2
5.3	33.6	47.5	66.5	6	2.63	-	164.4	622.3	38.2	21.07	5.97	164.4	83.67	116.53	133.57	48.37	7.43
-	7.89	10.18	13.52	1.98	0.85	-	22.72	65.2	11.43	-	2.16	22.72	17.89	18.5	18.39	13.47	2.19
-	1.86	1.28	1.38	0.81	0.6	-	2.23	6.08	3.05	-	1.08	2.23	2.76	1.71	2.15	4.06	0.98
5.3	5.9	7.7	7.35	2.77	2.03	-	13.9	11.6	5.51	21.07	2.77	13.9	4.33	7.27	4.9	8.1	3.96
-	3.92	3.43	3.69	2.08	7.62	-	5.95	16.25	6.6	-	3.43	5.95	7.38	4.57	5.75	9.05	2.72
0.33	6	21	32	2	0.67	-	34.67	38.33	4.67	0.33	1.33	34.67	14	39	24.33	3.67	1.67

S1 Group Cont. **Subject Emotional State** **Subject Posture**

2 h Upper	H N/A	neutral/calm	anxious	confident	insecure	interested	bored/tired	positive	negative other emotion 1	E N/A	straight	leaning front	leaning back	P N/A
-	80	23	9	2	-	64	7	3	-	-	80	64	6	18	80
-	0.89	0.26	0.1	0.02	-	0.71	0.08	0.03	-	-	0.89	0.71	0.07	0.2	0.89
-	3071.07	201.43	124.27	20.87	-	1817.2	157.05	8.2	-	-	3071.07	1041.36	658.25	629.41	3071.07
-	56.87	3.73	2.3	0.39	-	**33.65**	2.91	0.15	-	-	56.87	**19.28**	12.19	11.66	56.87
-	38.39	8.76	13.81	10.44	-	28.39	22.44	2.73	-	-	38.39	16.27	109.71	34.97	38.39
-	3.9	1.26	0.9	8.5	-	1	5.47	0.87	-	-	3.9	0.9	2.37	1.93	3.9
-	244.63	20.47	75.97	12.37	-	253	54.33	5.83	-	-	244.63	253	626.8	268.64	244.63
-	42.03	6.18	24.67	2.74	-	48.86	16.75	2.7	-	-	42.03	36.11	253.35	63.15	42.03
-	4.7	1.29	8.22	1.94	-	6.11	6.33	1.56	-	-	4.7	4.51	103.43	14.88	4.7
-	24.04	6.97	3.53	10.44	-	9.47	20.37	1.5	-	-	24.04	5.99	6.86	9.64	24.04
-	12.56	2.67	18.96	24.59	-	16.32	15.5	6.71	-	-	12.56	12.06	265.92	31.41	12.56
-	26.67	7.67	3	0.67	-	21.33	2.33	1	-	-	26.67	21.33	2	6	26.67

S2 Group Cont. **Subject Emotional State** **Subject Posture**

2 h Upper	H N/A	neutral/calm	anxious	confident	insecure	interested	bored/tired	positive	negative other emotion 1	E N/A	straight	leaning front	leaning back	P N/A
2	104	58	6	3	2	84	39	10	1	-	104	60	50	46	104
0.02	1.16	0.64	0.07	0.03	0.02	0.93	0.43	0.11	0.01	-	1.16	0.67	0.56	0.51	1.16
16.3	2225.49	1043.94	68.1	47.19	20.7	1462.99	475.59	55.36	0.73	-	2225.49	1736.49	488.8	949.31	2225.49
0.3	41.21	19.33	1.26	0.87	0.38	27.09	8.81	1.03	0.01	-	41.21	32.16	9.05	17.58	41.21
8.15	21.4	18	11.35	15.73	10.35	17.42	12.19	5.54	0.73	-	21.4	28.94	9.78	20.64	21.4
5.3	1.8	0.4	4.2	8.83	4.1	1.23	0.94	1.43	0.73	-	1.8	1.23	0.93	0.87	1.8
11	164.4	104.8	24.27	22.73	16.6	76.2	62.93	16.96	0.73	-	164.4	243.9	38.13	120	164.4
4.03	22.72	20.8	7.52	6.95	8.84	17.2	14.11	4.4	-	-	22.72	44.04	8.76	24.97	22.72
2.85	2.23	2.73	3.07	4.01	6.25	1.88	2.26	1.39	-	-	2.23	5.69	1.24	3.68	2.23
8.15	13.9	10.23	9.64	15.63	10.35	11.09	6.97	4.4	0.73	-	13.9	10.52	6.72	12.14	13.9
36.21	5.95	7.3	7.9	17.27	79.41	5.01	6.04	3.15	-	-	5.95	15.19	3.31	9.84	5.95
0.67	34.67	19.33	2	1	0.67	28	13	3.33	0.33	-	34.67	20	16.67	15.33	34.67

S3 Group	Delivery Channel				Gesture Action							
Statistic *Behavior*	Gesture-Only	Verbal-Only	Gesture+Verbal	DC N/A	raise h	cross arms	roll h	h in chin	h in mouth	leaning on h	hiding h	physical
Total number	94	9	15	84	1	4	11	11	5	24	-	29
Rate (number per minute)	1.04	0.1	0.17	0.93	0.01	0.04	0.12	0.12	0.06	0.27	-	0.32
Total duration (s)	2519.46	54.73	123.41	2702.49	0.8	29.26	51.89	77.99	27.04	211.96	-	144.3
Total duration (% of observation)	46.66	1.01	2.29	50.05	0.01	0.54	0.96	1.44	0.5	3.93	-	2.67
Mean duration (s)	26.8	6.08	8.23	32.17	0.8	7.32	4.72	7.09	5.41	8.83	-	4.98
Minimum duration (s)	0.96	2.44	1.36	2.56	0.8	3.33	0.77	1.36	1.6	2.93	-	0.9
Maximum duration (s)	621.3	17.36	21.57	264.37	0.8	11.4	16.7	14.5	10.87	26.5	-	19.7
Standard deviation of duration (s)	69.78	4.52	6.01	41	-	3.45	5.06	4.77	3.37	5.33	-	4.54
Standard error of mean duration (s)	7.2	1.51	1.55	4.47	-	1.72	1.52	1.44	1.51	1.09	-	0.84
Median duration (s)	9.69	4.77	6.64	20.55	0.8	7.27	1.8	5.83	4.97	7.35	-	3.06
Confidence interval of duration (s)	19.23	3.47	3.33	11.95	-	5.48	3.4	3.21	4.18	2.25	-	1.73
Mean total of observations	31.33	3	5	28	0.33	1.33	3.67	3.67	1.67	8	-	9.67

S4 Group	Delivery Channel				Gesture Action							
Statistic *Behavior*	Gesture-Only	Verbal-Only	Gesture+Verbal	DC N/A	raise h	cross arms	roll h	h in chin	h in mouth	leaning on h	hiding h	physical
Total number	102	2	6	95	-	10	-	13	30	46	19	45
Rate (number per minute)	1.13	0.02	0.07	1.06	-	0.11	-	0.14	0.33	0.51	0.21	0.5
Total duration (s)	2897.97	6.8	21.1	2474.22	-	361.73	-	120.67	321	952.23	276.96	270.37
Total duration (% of observation)	53.67	0.13	0.39	45.82	-	6.7	-	2.23	5.94	17.63	5.13	5.01
Mean duration (s)	28.41	3.4	3.52	26.04	-	36.17	-	9.28	10.7	20.7	14.58	6.01
Minimum duration (s)	0.8	1.9	1.63	2.07	-	0.56	-	1.14	1.43	1.3	1.23	0.9
Maximum duration (s)	621.9	4.9	5.14	170.14	-	261.2	-	26.1	40.44	197.16	40.77	15
Standard deviation of duration (s)	68.2	2.12	1.38	25.02	-	79.9	-	6.92	11.54	32.91	11.98	3.73
Standard error of mean duration (s)	6.75	1.5	0.56	2.57	-	25.27	-	1.92	2.11	4.85	2.75	0.56
Median duration (s)	12.7	3.4	3.5	19.2	-	9.82	-	8.74	6.52	8.92	12.57	5.7
Confidence interval of duration (s)	18.04	19.06	1.45	6.86	-	57.16	-	4.18	4.31	12.97	5.78	1.49
Mean total of observations	34	0.67	2	31.67	-	3.33	-	4.33	10	15.33	6.33	15

S3 Group Cont.

								Gesture Direction					Hand(s) and Space Used				
h behind head	hand movement	instrumental	neutral	pointing	cross fingers	other action	A N/A	oneself/none	a person	group	something	D N/A	1 h Low	2 h Low	1 h Middle	2 h Middle	1 h Upper
-	28	93	75	-	-	-	84	94	11	4	-	84	74	90	46	11	5
-	0.31	1.03	0.83	-	-	-	0.93	1.04	0.12	0.04	-	0.93	0.82	1	0.51	0.12	0.06
-	242.22	1023.71	888.25	-	-	-	2702.67	2595.04	48.04	54.34	-	2702.67	1027.81	1171.85	392.4	76.55	28.81
-	4.49	18.96	16.45	-	-	-	50.05	48.06	0.89	1.01	-	50.05	19.03	21.7	7.27	1.42	0.53
-	8.65	11.01	11.84	-	-	-	32.17	27.61	4.37	13.59	-	32.17	13.89	13.02	8.53	6.96	5.76
-	0.57	1.17	0.5	-	-	-	2.57	0.93	0.77	4.4	-	2.57	0.53	0.5	0.9	1.14	1.04
-	26.63	50.93	60.1	-	-	-	264.4	621.3	13.94	23.5	-	264.4	107.8	69.23	43.6	33.3	11.2
-	6.37	10.68	12.28	-	-	-	41	69.92	4.21	8.71	-	41	18.43	13.04	9.31	8.98	4.3
-	1.2	1.11	1.42	-	-	-	4.47	7.21	1.27	4.35	-	4.47	2.14	1.37	1.37	2.71	1.92
-	7.23	7.17	7.4	-	-	-	20.6	9.38	2.64	13.22	-	20.6	8.34	9.12	4.7	4.83	6
-	2.47	2.96	3.79	-	-	-	11.95	19.27	2.83	13.85	-	11.95	5.72	3.67	3.67	6.03	5.34
-	9.33	31	25	-	-	-	28	31.33	3.67	1.33	-	28	24.67	30	15.33	3.67	1.67

S4 Group Cont.

								Gesture Direction					Hand(s) and Space Used				
h behind head	hand movement	instrumental	neutral	pointing	cross fingers	other action	A N/A	oneself/none	a person	group	something	D N/A	1 h Low	2 h Low	1 h Middle	2 h Middle	1 h Upper
-	3	21	27	-	2	2	94	102	4	2	-	94	23	53	64	5	1
-	0.03	0.23	0.3	-	0.02	0.02	1.04	1.13	0.04	0.02	-	1.04	0.26	0.59	0.71	0.06	0.01
-	9.71	330.89	263.7	-	26.66	18.54	2447.63	2931.53	10.86	10.07	-	2447.63	345.81	959.23	1333.79	304.6	5.13
-	0.18	6.13	4.88	-	0.49	0.34	45.33	54.29	0.2	0.19	-	45.33	6.4	17.76	24.7	5.64	0.09
-	3.24	15.76	9.77	-	13.33	9.27	26.04	28.74	2.72	5.04	-	26.04	15.04	18.1	20.84	60.92	5.13
-	2	0.9	0.54	-	11.93	7.87	2.06	1.23	2	4.9	-	2.06	0.9	0.56	1.1	0.84	5.13
-	5.44	99.76	45.77	-	14.73	10.67	170.17	621.9	3.96	5.17	-	170.17	99.76	261.2	166.2	219.33	5.13
-	1.91	24.39	9.92	-	1.98	1.98	25.16	68.23	0.87	0.19	-	25.16	22.12	36.08	26.68	91.01	-
-	1.1	5.32	1.91	-	1.4	1.4	2.59	6.76	0.43	0.14	-	2.59	4.61	4.96	3.34	40.7	-
-	2.27	5.33	7.1	-	13.33	9.27	19.05	12.7	2.45	5.04	-	19.05	6.67	11.47	11.12	32.7	5.13
-	4.75	11.1	3.93	-	17.79	17.79	6.93	18.05	1.38	1.72	-	6.93	9.57	13.24	8.91	112.99	-
-	1	7	9	-	0.67	0.67	31.33	34	1.33	0.67	-	31.33	7.67	17.67	21.33	1.67	0.33

S3 Group Cont.

2 h Upper	H N/A	neutral/calm	anxious	confident	insecure	interested	bored/tired	positive	negative other emotion 1	E N/A	straight	leaning front	leaning back	P N/A
	Subject Emotional State									**Subject Posture**				
-	84	27	8	3	3	85	40	2	- -	84	33	66	35	84
-	0.93	0.3	0.09	0.03	0.03	0.94	0.44	0.02	- -	0.93	0.37	0.73	0.39	0.93
-	2702.67	332.68	125.75	40.84	33.42	1704.07	453.9	6.76	- -	2702.67	527.2	1645.64	524.58	2702.67
-	50.05	6.16	2.33	0.76	0.62	31.56	8.41	0.13	- -	50.05	9.76	30.47	9.71	50.05
-	32.17	12.32	15.72	13.61	11.14	20.05	11.35	3.38	- -	32.17	15.98	24.93	14.99	32.17
-	2.57	0.93	6.34	1.8	7.03	1.3	0.57	2.6	- -	2.57	1.03	1.3	0.93	2.57
-	264.4	44.67	32.53	28.34	16.63	159.23	39.97	4.16	- -	264.4	62.17	102.86	75.5	264.4
-	41	11.58	8.83	13.51	4.95	26.57	7.94	1.1	- -	41	15.11	25.91	15.91	41
-	4.47	2.23	3.12	7.8	2.86	2.88	1.26	0.78	- -	4.47	2.63	3.19	2.69	4.47
-	20.6	8.5	11.84	10.7	9.76	10.87	10.39	3.38	- -	20.6	10.23	15.19	9.13	20.6
-	11.95	4.58	7.38	33.56	12.29	7.7	3.35	9.91	- -	11.95	7.03	8.52	7.19	11.95
-	28	9	2.67	1	1	28.33	13.33	0.67	- -	28	11	22	11.67	28

S4 Group Cont.

2 h Upper	H N/A	neutral/calm	anxious	confident	insecure	interested	bored/tired	positive	negative other emotion 1	E N/A	straight	leaning front	leaning back	P N/A
	Subject Emotional State									**Subject Posture**				
1	94	14	1	3	2	66	69	-	- 1	94	17	42	61	94
0.01	1.04	0.16	0.01	0.03	0.02	0.73	0.77	-	- 0.01	1.04	0.19	0.47	0.68	1.04
3.9	2447.63	447.81	15.73	21.97	10.26	1093.52	1356.74	-	- 6.43	2447.63	205.21	1498.04	1249.21	2447.63
0.07	45.33	8.29	0.29	0.41	0.19	20.25	25.12	-	- 0.12	45.33	3.8	27.74	23.13	45.33
3.9	26.04	31.99	15.73	7.32	5.13	16.57	19.66	-	- 6.43	26.04	12.07	35.67	20.48	26.04
3.9	2.06	2.23	15.73	3.43	4.9	0.9	0.37	-	- 6.43	2.06	0.93	0.9	1.23	2.06
3.9	170.17	261.16	15.73	10.67	5.36	99.76	219.33	-	- 6.43	170.17	80.87	298.8	261.2	170.17
-	25.16	66.53	-	3.65	0.33	16.65	31.36	-	- -	25.16	19.01	61.56	34.56	25.16
-	2.59	17.78	-	2.11	0.23	2.05	3.78	-	- -	2.59	4.61	9.5	4.43	2.59
3.9	19.05	13.37	15.73	7.87	5.13	11.74	10	-	- 6.43	19.05	6.03	13.68	12.57	19.05
-	6.93	38.41	-	9.07	2.92	5.48	10.09	-	- -	6.93	9.77	25.38	8.85	6.93
0.33	31.33	4.67	0.33	1	0.67	22	23	-	- 0.33	31.33	5.67	14	20.33	31.33

S6 Group		**Delivery Channel**				**Gesture Action**							
Statistic	*Behavior*	Gesture-Only	Verbal-Only	Gesture+Verbal	DC N/A	raise h	cross arms	roll h	h in chin	h in mouth	leaning on h	hiding h	physical
Total number		65	4	21	54	4	-	24	9	3	3	1	11
Rate (number per minute)		0.72	0.04	0.23	0.6	0.04	-	0.27	0.1	0.03	0.03	0.01	0.12
Total duration (s)		1546.44	26.48	429.01	3398.16	9.18	-	256.93	98.86	12.64	41.06	1.83	75.17
Total duration (% of observation)		28.64	0.49	7.94	62.93	0.17	-	4.76	1.83	0.23	0.76	0.03	1.39
Mean duration (s)		23.79	6.62	20.43	62.93	2.3	-	10.71	10.98	4.21	13.69	1.83	6.83
Minimum duration (s)		1.3	3.34	0.13	2.07	1.04	-	1.17	2.47	0.84	5.1	1.83	1.13
Maximum duration (s)		254.33	11.77	92.1	1800.03	4.1	-	40.93	37.6	10.16	20.8	1.83	23
Standard deviation of duration (s)		38.94	4.03	23.82	243.4	1.43	-	10.23	10.81	5.17	7.95	-	6.89
Standard error of mean duration (s)		4.83	2.02	5.2	33.12	0.71	-	2.09	3.6	2.98	4.59	-	2.08
Median duration (s)		13.5	5.69	12.8	18.52	2.02	-	7.55	9.67	1.64	15.16	1.83	3.5
Confidence interval of duration (s)		12.91	6.42	10.84	88.5	2.27	-	4.32	8.31	12.83	19.76	-	4.63
Mean total of observations		21.67	1.33	7	18	1.33	-	8	3	1	1	0.33	3.67

R1 Group		**Delivery Channel**				**Gesture Action**							
Statistic	*Behavior*	Gesture-Only	Verbal-Only	Gesture+Verbal	DC N/A	raise h	cross arms	roll h	h in chin	h in mouth	leaning on h	hiding h	physical
Total number		24	-	7	20	-	2	3	2	2	6	-	10
Rate (number per minute)		0.27	-	0.08	0.22	-	0.02	0.03	0.02	0.02	0.07	-	0.11
Total duration (s)		1235.55	-	87.42	4077.12	-	12.91	60.48	7.53	37.9	96.66	-	47.24
Total duration (% of observation)		22.88	-	1.62	75.5	-	0.24	1.12	0.14	0.7	1.79	-	0.87
Mean duration (s)		51.48	-	12.49	203.86	-	6.46	20.16	3.77	18.95	16.11	-	4.72
Minimum duration (s)		1.5	-	1.03	4.8	-	6.07	3.6	2.5	14.77	2.4	-	1.36
Maximum duration (s)		379.2	-	45.63	1800.03	-	6.84	44.74	5.03	23.13	45.9	-	26.87
Standard deviation of duration (s)		84.81	-	15.68	443.04	-	0.54	21.71	1.79	5.91	16.62	-	7.83
Standard error of mean duration (s)		17.31	-	5.93	99.07	-	0.39	12.53	1.26	4.18	6.78	-	2.48
Median duration (s)		20.93	-	8.2	43.8	-	6.46	12.14	3.77	18.95	9.94	-	2.12
Confidence interval of duration (s)		35.82	-	14.5	207.35	-	4.89	53.94	16.07	53.11	17.44	-	5.6
Mean total of observations		8	-	2.33	6.67	-	0.67	1	0.67	0.67	2	-	3.33

S6 Group Cont.

								Gesture Direction					Hand(s) and Space Used				
h behind head	hand movement	instrumental	neutral	pointing	cross fingers	other action	A N/A	oneself/none	a person	group	something	D N/A	1 h Low	2 h Low	1 h Middle	2 h Middle	1 h Upper
-	19	28	27	1	26	-	54	69	22	5	1	54	9	68	33	18	4
-	0.21	0.31	0.3	0.01	0.29	-	0.6	0.77	0.24	0.06	0.01	0.6	0.1	0.76	0.37	0.2	0.04
-	355.99	449.81	425.66	1.27	268.8	-	3402.89	1652.07	225.11	93.32	1.07	3428.52	220.24	1182.06	391.41	194.23	9.26
-	6.59	8.33	7.88	0.02	4.98	-	63.02	30.59	4.17	1.73	0.02	63.49	4.08	21.89	7.25	3.6	0.17
-	18.74	16.06	15.77	1.27	10.34	-	63.02	23.94	10.23	18.66	1.07	63.49	24.47	17.38	11.86	10.79	2.32
-	1.6	0.57	1.4	1.27	1.1	-	2.1	0.57	1.04	1.14	1.07	2.1	1.83	0.57	0.84	2.67	1.23
-	47.93	66.34	93.1	1.27	35.33	-	1800.03	254.33	43.53	33.13	1.07	1800.03	123.4	73.5	37.6	23.54	4.1
-	15.97	18.48	19.95	-	10.09	-	243.39	38.67	10.13	14.35	-	243.36	39.8	18.18	10.38	6.28	1.25
-	3.66	3.49	3.84	-	1.98	-	33.12	4.66	2.16	6.42	-	33.12	13.27	2.2	1.81	1.48	0.63
-	10.4	9.19	8.9	1.27	6.59	-	18.52	13	6.8	24.04	1.07	18.52	12.44	10.28	9.67	10.9	1.97
-	7.7	7.17	7.9	-	4.07	-	88.5	12.44	4.49	17.81	-	88.49	30.6	5.89	4.83	3.12	1.99
-	6.33	9.33	9	0.33	8.67	-	18	23	7.33	1.67	0.33	18	3	22.67	11	6	1.33

R1 Group Cont.

								Gesture Direction					Hand(s) and Space Used				
h behind head	hand movement	instrumental	neutral	pointing	cross fingers	other action	A N/A	oneself/none	a person	group	something	D N/A	1 h Low	2 h Low	1 h Middle	2 h Middle	1 h Upper
-	20	14	25	-	-	-	20	18	-	3	1	20	11	30	17	1	-
-	0.22	0.16	0.28	-	-	-	0.22	0.2	-	0.03	0.01	0.22	0.12	0.33	0.19	0.01	-
-	383.1	268.43	406.12	-	-	-	4079.72	1229.49	-	85.31	5.57	4079.72	247.85	900.62	169.9	2	-
-	7.09	4.97	7.52	-	-	-	75.55	22.77	-	1.58	0.1	75.55	4.59	16.68	3.15	0.04	-
-	19.16	19.17	16.24	-	-	-	203.99	68.31	-	28.44	5.57	203.99	22.53	30.02	9.99	2	-
-	1.63	5.27	1.5	-	-	-	4.8	5.1	-	19.07	5.57	4.8	5.67	5.1	1.36	2	-
-	58.8	47.7	63.47	-	-	-	1800.03	656.33	-	34.54	5.57	1800.03	58.8	176.56	71.87	2	-
-	13.48	12.12	16.03	-	-	-	443	152.47	-	8.24	-	443	15.54	32.58	17.05	-	-
-	3.01	3.24	3.21	-	-	-	99.06	35.94	-	4.75	-	99.06	4.69	5.95	4.14	-	-
-	16.17	17.36	8.83	-	-	-	44.35	22.77	-	31.7	5.57	44.35	16.94	21.1	3.77	2	-
-	6.31	7	6.62	-	-	-	207.33	75.83	-	20.46	-	207.33	10.44	12.17	8.77	-	-
-	6.67	4.67	8.33	-	-	-	6.67	6	-	1	0.33	6.67	3.67	10	5.67	0.33	-

S6 Group Cont.

		Subject Emotional State									Subject Posture				
2 h Upper	H N/A	neutral/calm	anxious	confident	insecure	interested	bored/tired	positive	negative	other emotion 1	E N/A	straight	leaning front	leaning back	P N/A
-	54	34	9	20	5	56	14	5	1	-	54	15	1	47	54
-	0.6	0.38	0.1	0.22	0.06	0.62	0.16	0.06	0.01	-	0.6	0.17	0.01	0.52	0.6
-	3402.89	378.52	141.7	258.6	87.74	943.18	167.13	18.63	1.7	-	3402.89	759.09	0.57	1239.8	3400.63
-	63.02	7.01	2.62	4.79	1.62	17.47	3.09	0.34	0.03	-	63.02	14.06	0.01	22.96	62.97
-	63.02	11.13	15.74	12.93	17.55	16.84	11.94	3.73	1.7	-	63.02	50.61	0.57	26.38	62.97
-	2.1	0.1	1.6	1.17	2.4	0.57	2.27	1.6	1.7	-	2.1	1.4	0.57	1.3	2.1
-	1800.03	37.9	47.9	40.93	54.97	153.1	62.67	6.73	1.7	-	1800.03	198.8	0.57	194.67	1800.03
-	243.39	11.2	15.2	10.19	21.68	24.83	15.59	1.98	-	-	243.39	56.41	-	37.55	243.4
-	33.12	1.92	5.07	2.28	9.7	3.32	4.17	0.88	-	-	33.12	14.57	-	5.48	33.12
-	18.52	6.92	10.2	10.53	7.93	10.05	6.59	3.4	1.7	-	18.52	27.8	0.57	15.36	18.52
-	88.5	5.13	11.69	4.77	26.92	8.87	9	2.45	-	-	88.5	31.24	-	14.63	88.5
-	18	11.33	3	6.67	1.67	18.67	4.67	1.67	0.33	-	18	5	0.33	15.67	18

R1 Group Cont.

		Subject Emotional State									Subject Posture				
2 h Upper	H N/A	neutral/calm	anxious	confident	insecure	interested	bored/tired	positive	negative	other emotion 1	E N/A	straight	leaning front	leaning back	P N/A
-	20	3	8		2	24	12	-	-	-	20	11	10	10	20
-	0.22	0.03	0.09		0.02	0.27	0.13	-	-	-	0.22	0.12	0.11	0.11	0.22
-	4079.72	49.4	106.1		31.96	815.79	317.12	-	-	-	4079.72	633.82	414.83	271.72	4079.72
-	75.55	0.91	1.96		0.59	15.11	5.87	-	-	-	75.55	11.74	7.68	5.03	75.55
-	203.99	16.47	13.26		15.98	33.99	26.43	-	-	-	203.99	57.62	41.48	27.17	203.99
-	4.8	9.3	2		8.8	1.5	4.97	-	-	-	4.8	1.63	4.83	3.36	4.8
-	1800.03	21.1	30.2		23.16	134.9	85.87	-	-	-	1800.03	486.27	114.76	107.33	1800.03
-	443	6.29	10.45		10.15	36.84	21.99	-	-	-	443	142.98	35.41	30.75	443
-	99.06	3.63	3.69		7.18	7.52	6.35	-	-	-	99.06	43.11	11.2	9.72	99.06
-	44.35	19	12.43		15.98	20.12	22.04	-	-	-	44.35	12.4	27.6	21.94	44.35
-	207.33	15.64	8.73		91.23	15.56	13.97	-	-	-	207.33	96.05	25.33	21.99	207.33
-	6.67	1	2.67		0.67	8	4	-	-	-	6.67	3.67	3.33	3.33	6.67

R2 Group	**Delivery Channel**				**Gesture Action**							
Statistic	*Behavior*	Gesture-Only	Verbal-Only	Gesture+Verbal	DC N/A	raise h	cross arms	roll h	h in chin	h in mouth	leaning on h	hiding h	physical
Total number		55	-	5	53	-	1	5	6	8	16	1	27
Rate (number per minute)		0.61	-	0.06	0.59	-	0.01	0.06	0.07	0.09	0.18	0.01	0.3
Total duration (s)		1447.48	-	39.4	3913.21	-	28.07	19.3	21.53	43.86	117.31	28.87	109.56
Total duration (% of observation)		26.8	-	0.73	72.47	-	0.52	0.36	0.4	0.81	2.17	0.53	2.03
Mean duration (s)		26.32	-	7.88	73.83	-	28.07	3.86	3.59	5.48	7.33	28.87	4.06
Minimum duration (s)		1.2	-	1.33	2.17	-	28.07	0.97	0.9	1.23	0.63	28.87	1.34
Maximum duration (s)		349.3	-	25.1	670.4	-	28.07	8.7	8.13	16.83	22.96	28.87	16.57
Standard deviation of duration (s)		54.05	-	9.94	113.39	-	-	3.08	2.64	5.16	6.17	-	3.37
Standard error of mean duration (s)		7.29	-	4.44	15.57	-	-	1.38	1.08	1.82	1.54	-	0.65
Median duration (s)		9.94	-	3.9	32.14	-	28.07	3.83	3.04	3.65	5.77	28.87	2.9
Confidence interval of duration (s)		19.47	-	12.33	41.62	-	-	3.82	2.77	4.32	3.29	-	1.34
Mean total of observations		18.33	-	1.67	17.67	-	0.33	1.67	2	2.67	5.33	0.33	9

R2 Group Cont.

								Gesture Direction					Hand(s) and Space Used				
h behind head	hand movement	instrumental	neutral	pointing	cross fingers	other action	A N/A	oneself/none	a person	group	something	D N/A	1 h Low	2 h Low	1 h Middle	2 h Middle	1 h Upper
-	11	43	36	-	-	-	53	53	-	-	3	53	21	55	35	1	2
-	0.12	0.48	0.4	-	-	-	0.59	0.59	-	-	0.03	0.59	0.23	0.61	0.39	0.01	0.02
-	106.31	407.23	603.19	-	-	-	3914.86	1450.27	-	-	34.96	3914.86	169.36	1044.93	264.11	2.43	4.4
-	1.97	7.54	11.17	-	-	-	72.5	26.86	-	-	0.65	72.5	3.14	19.35	4.89	0.04	0.08
-	9.66	9.47	16.76	-	-	-	73.87	27.36	-	-	11.65	73.87	8.06	19	7.55	2.43	2.2
-	2.73	0.53	0.47	-	-	-	2.17	1.2	-	-	3.83	2.17	1.77	0.53	1.26	2.43	1.63
-	18.23	39.5	75.9	-	-	-	670.4	349.3	-	-	23.66	670.4	28.14	92.5	44.37	2.43	2.77
-	5.49	8.69	20.31	-	-	-	113.4	54.99	-	-	10.56	113.4	6.15	21.02	8.94	-	0.81
-	1.66	1.32	3.39	-	-	-	15.58	7.55	-	-	6.09	15.58	1.34	2.83	1.51	-	0.57
-	10.1	6.9	11.85	-	-	-	32.17	12.5	-	-	7.47	32.17	5.53	12.8	4.8	2.43	2.2
-	3.69	3.54	9.05	-	-	-	41.62	20.18	-	-	26.23	41.62	2.8	7.57	4.04	-	7.24
-	3.67	14.33	12	-	-	-	17.67	17.67	-	-	1	17.67	7	18.33	11.67	0.33	0.67

R2 Group Cont.		**Subject Emotional State**									**Subject Posture**				
2 h Upper	H N/A	neutral/calm	anxious	confident	insecure	interested	bored/tired	positive	negative	other emotion 1	E N/A	straight	leaning front	leaning back	P N/A
-	53	9	4	2	-	56	24	9	-	1	53	17	43	13	53
-	0.59	0.1	0.04	0.02	-	0.62	0.27	0.1	-	0.01	0.59	0.19	0.48	0.14	0.59
-	3914.86	77.34	88.41	1.89	-	922.47	357.72	35.27	-	2.13	3914.86	717.23	625.76	142.24	3914.86
-	72.5	1.43	1.64	0.03	-	17.08	6.62	0.65	-	0.04	72.5	13.28	11.59	2.63	72.5
-	73.87	8.59	22.1	0.95	-	16.47	14.91	3.92	-	2.13	73.87	42.19	14.55	10.94	73.87
-	2.17	0.44	5.3	0.86	-	1.2	1.33	2.16	-	2.13	2.17	1.03	1.2	1.3	2.17
-	670.4	18.53	45.47	1.03	-	108.23	61.4	6.67	-	2.13	670.4	333.37	67.97	64.8	670.4
-	113.4	6.15	17.25	0.12	-	21.34	14.12	1.4	-	-	113.4	80.57	13.72	17.07	113.4
-	15.58	2.05	8.63	0.09	-	2.85	2.88	0.47	-	-	15.58	19.54	2.09	4.74	15.58
-	32.17	10.04	18.82	0.95	-	8.48	10.07	3.53	-	2.13	32.17	18.03	9.93	6	32.17
-	41.62	4.72	27.45	1.08	-	7.62	5.96	1.08	-	-	41.62	41.43	5.59	10.32	41.62
-	17.67	3	1.33	0.67	-	18.67	8	3	-	0.33	17.67	5.67	14.33	4.33	17.67

Participant Demographics

		Enrollment		Gender		Affiliation				
		NCSU	other	male	female	undergrad	grad	faculty	industry	other
SIGs Group	Count	25	5	28	3	20	6	0	3	2
	Total %	**28.09%**	5.62%	**31.11%**	3.33%	**22.22%**	6.67%	0.00%	3.33%	2.22%
	Group %	**83.33%**	16.67%	**90.32%**	9.68%	**64.52%**	19.35%	0.00%	9.68%	6.45%
VCAs-SIGs Group	Count	26	4	23	7	22	4	2	2	0
	Total %	**29.21%**	4.49%	**25.56%**	7.78%	**24.44%**	4.44%	2.22%	2.22%	0.00%
	Group %	**86.67%**	13.33%	**76.67%**	23.33%	**73.33%**	13.33%	6.67%	6.67%	0.00%
VCAs Group	Count	24	5	23	6	21	2	1	1	4
	Total %	**26.97%**	5.62%	**25.56%**	6.67%	**23.33%**	2.22%	1.11%	1.11%	4.44%
	Group %	**82.76%**	17.24%	**79.31%**	20.69%	**72.41%**	6.90%	3.45%	3.45%	13.79%
All Groups	Count	75	14	74	16	63	12	3	6	6
	Total %	**84.27%**	15.73%	**82.22%**	17.78%	**70.00%**	13.33%	3.33%	6.67%	6.67%
			89		90					90
			100.00%		100.00%					100.00%

1 blank answer

Age			Language		DE experience		DE Times		
18-24	25-31	over 32	english	other	yes	no	0 times	1 time	2 times
21	5	5	26	5	9	22	22	5	4
23.33%	5.56%	5.56%	**28.89%**	5.56%	10.00%	**24.44%**	**24.44%**	5.56%	4.44%
67.74%	16.13%	16.13%	**83.87%**	16.13%	29.03%	**70.97%**	**70.97%**	16.13%	12.90%
21	4	5	28	2	6.00	24.00	24	2	4
23.33%	4.44%	5.56%	**31.11%**	2.22%	6.67%	**26.67%**	**26.67%**	2.22%	4.44%
70.00%	13.33%	16.67%	**93.33%**	6.67%	20.00%	**80.00%**	**80.00%**	6.67%	13.33%
23	1	5	27	2	2	27	26	1	2
25.56%	1.11%	5.56%	**30.00%**	2.22%	2.22%	**30.00%**	**28.89%**	1.11%	2.22%
79.31%	3.45%	17.24%	**87.10%**	6.45%	6.90%	**93.10%**	**89.66%**	3.45%	6.90%
65	10	15	81	9	17	73	72	8	10
72.22%	11.11%	16.67%	**90.00%**	10.00%	18.89%	**81.11%**	**80.00%**	8.89%	11.11%
		90		90		90			90
		100.00%		100.00%		100.00%			100.00%

Active Participation - Actor ranking

		G1			G2			
		X1	**X2**	**X3**	**X4**	**X5**	**X6**	Totals
SIGs Group	Count	13	7	4	6	11	11	31.00
	Total %	14.44%	7.78%	4.44%	6.67%	12.22%	12.22%	34.44%
	Group %	41.94%	22.58%	12.90%	19.35%	35.48%	35.48%	100.00%
VCAs-SIGs Group	Count	18	13	9	7	7	10	30.00
	Total %	**20.00%**	**14.44%**	10.00%	7.78%	7.78%	11.11%	33.33%
	Group %	60.00%	43.33%	30.00%	23.33%	23.33%	33.33%	100.00%
VCAs Group	Count	13	10	11	6	7	10	29.00
	Total %	14.44%	11.11%	**12.22%**	6.67%	7.78%	11.11%	32.22%
	Group %	44.83%	34.48%	37.93%	20.69%	24.14%	34.48%	100.00%
All Groups	Count	44	30	24	19	25	31	90.00
	Total %	48.89%	33.33%	26.67%	21.11%	27.78%	34.44%	100.00%

Description of Participation - Most Assessment

		Gestural/Visual	Both	Verbal	Neutral No opinion	Totals
SIGs Group	Count	2	9	18	2	31
	Total %	2.22%	10.00%	20.00%	2.22%	34.44%
	Group %	6.45%	29.03%	**58.06%**	6.45%	100.00%
VCAs-SIGs Group	Count	6	5	18	1	30
	Total %	6.67%	5.56%	20.00%	1.11%	33.33%
	Group %	20.00%	16.67%	**60.00%**	3.33%	100.00%
VCAs Group	Count	4	0	22	3	29
	Total %	4.44%	0.00%	24.44%	3.33%	32.22%
	Group %	13.79%	0.00%	**75.86%**	10.34%	100.00%
All Groups	Count	12	14	58	6	90
	Total %	13.33%	15.56%	**64.44%**	6.67%	100.00%

Description of Participation - Least Assessment

		Gestural/Visual	Both	Verbal	Neutral No opinion	Totals
SIGs Group	Count	2	6	22	1	31
	Total %	2.22%	6.67%	24.44%	1.11%	34.44%
	Group %	6.45%	19.35%	**70.97%**	3.23%	100.00%
VCAs-SIGs Group	Count	3	7	18	2	30
	Total %	3.33%	7.78%	20.00%	2.22%	33.33%
	Group %	10.00%	23.33%	**60.00%**	6.67%	100.00%
VCAs Group	Count	2	1	23	3	29
	Total %	2.22%	1.11%	25.56%	3.33%	32.22%
	Group %	6.90%	3.45%	**79.31%**	10.34%	100.00%
All Groups	Count	7	14	63	6	90
	Total %	7.78%	15.56%	**70.00%**	6.67%	100.00%

		Call for attention - Assessment				Call for attention -Interaction Choice			
		Verbal	**Gestural/ Visual**	**Both**	Totals	**Verbal**	**Gestural/ Visual**	**Both**	Totals
SIGs Group	Count	0	5	26	31	2	21	8	31
	Total %	0.00%	5.56%	**28.89%**	34.44%	2.22%	**23.33%**	8.89%	34.44%
	Group %	0.00%	16.13%	**83.87%**	100.00%	6.45%	**67.74%**	25.81%	100.00%
VCAs-SIGs Group	Count	0	3	27	30	4	19	7	30
	Total %	0.00%	3.33%	**30.00%**	33.33%	4.44%	**21.11%**	7.78%	33.33%
	Group %	0.00%	10.00%	**90.00%**	100.00%	13.33%	**63.33%**	23.33%	100.00%
VCAs Group	Count	7	3	19	29	4	9	16	29
	Total %	7.78%	3.33%	**21.11%**	32.22%	4.44%	10.00%	**17.78%**	32.22%
	Group %	24.14%	10.34%	**65.52%**	100.00%	13.79%	31.03%	**55.17%**	100.00%
All Groups	Count	7	11	72	90	10	49	31	90
	Total %	7.78%	12.22%	**80.00%**	100.00%	11.11%	**54.44%**	34.44%	100.00%

Call for attention - Checkmark actor

		G1			G2			
		X1	**X2**	**X3**	**X4**	**X5**	**X6**	Totals
SIGs Group	Count	29	29	29	5	3	5	31.00
	Total %	32.22%	32.22%	32.22%	5.56%	3.33%	5.56%	34.44%
	Group %	93.55%	93.55%	93.55%	16.13%	9.68%	16.13%	100.00%
VCAs-SIGs Group	Count	29	29	26	2	5	3	30.00
	Total %	32.22%	32.22%	28.89%	2.22%	5.56%	3.33%	33.33%
	Group %	96.67%	96.67%	86.67%	6.67%	16.67%	10.00%	100.00%
VCAs Group	Count	24	20	16	0	1	0	29.00
	Total %	26.67%	22.22%	17.78%	0.00%	1.11%	0.00%	32.22%
	Group %	82.76%	68.97%	55.17%	0.00%	3.45%	0.00%	100.00%
All Groups	Count	82	78	71	7	9	8	90.00
	Total %	91.11%	86.67%	78.89%	7.78%	10.00%	8.89%	100.00%

		Description of Call for Attention - Assessment				
		Gestural/Visual	**Both**	**Verbal**	**Neutral No opinion**	Totals
SIGs Group	Count	22	4	0	5	31
	Total %	24.44%	4.44%	0.00%	5.56%	34.44%
	Group %	**70.97%**	12.90%	0.00%	16.13%	100.00%
VCAs-SIGs Group	Count	28	1	0	1	30
	Total %	31.11%	1.11%	0.00%	1.11%	33.33%
	Group %	**93.33%**	3.33%	0.00%	3.33%	100.00%
VCAs Group	Count	27	0	2	0	29
	Total %	30.00%	0.00%	2.22%	0.00%	32.22%
	Group %	**93.10%**	0.00%	6.90%	0.00%	100.00%
All Groups	Count	77	5	2	6	90
	Total %	**85.56%**	5.56%	2.22%	6.67%	100.00%

		Avoid attention - Assessment				Avoid attention - Interaction Choice			
		Verbal	**Gestural/ Visual**	**Both**	Totals	**Verbal**	**Gestural/ Visual**	**Both**	Totals
SIGs Group	Count	18	1	12	31	27	0	4	31
	Total %	**20.00%**	1.11%	13.33%	34.44%	**30.00%**	0.00%	4.44%	34.44%
	Group %	**58.06%**	3.23%	38.71%	100.00%	**87.10%**	0.00%	12.90%	100.00%
VCAs-SIGs Group	Count	17	0	13	30	26	0	4	30
	Total %	**18.89%**	0.00%	14.44%	33.33%	**28.89%**	0.00%	4.44%	33.33%
	Group %	**56.67%**	0.00%	43.33%	100.00%	**86.67%**	0.00%	13.33%	100.00%
VCAs Group	Count	21	2	6	29	22	2	5	29
	Total %	**23.33%**	2.22%	6.67%	32.22%	**24.44%**	2.22%	5.56%	32.22%
	Group %	**72.41%**	6.90%	20.69%	100.00%	**75.86%**	6.90%	17.24%	100.00%
All Groups	Count	56	3	31	90	75	2	13	90
	Total %	**62.22%**	3.33%	34.44%	100.00%	**83.33%**	2.22%	14.44%	100.00%

Avoid attention - Checkmark actor

		G1			G2			
		X1	**X2**	**X3**	**X4**	**X5**	**X6**	Totals
SIGs Group	Count	3	10	20	4	5	3	31
	Total %	3.33%	11.11%	22.22%	4.44%	5.56%	3.33%	34.44%
	Group %	9.68%	32.26%	64.52%	12.90%	16.13%	9.68%	100.00%
VCAs-SIGs Group	Count	2	6	22	5	1	3	30
	Total %	2.22%	6.67%	24.44%	5.56%	1.11%	3.33%	33.33%
	Group %	6.67%	20.00%	73.33%	16.67%	3.33%	10.00%	100.00%
VCAs Group	Count	3	3	10	9	8	12	29
	Total %	3.33%	3.33%	11.11%	10.00%	8.89%	13.33%	32.22%
	Group %	10.34%	10.34%	34.48%	31.03%	27.59%	41.38%	100.00%
All Groups	Count	8	19	52	18	14	18	90
	Total %	8.89%	21.11%	57.78%	20.00%	15.56%	20.00%	100.00%

Description of Avoid Attention - Assessment

		Gestural/Visual	Both	Verbal	Neutral No opinion	Totals
SIGs Group	Count	27	0	0	4	31
	Total %	30.00%	0.00%	0.00%	4.44%	34.44%
	Group %	**87.10%**	0.00%	0.00%	12.90%	100.00%
VCAs-SIGs Group	Count	23	3	2	2	30
	Total %	25.56%	3.33%	2.22%	2.22%	33.33%
	Group %	**76.67%**	10.00%	6.67%	6.67%	100.00%
VCAs Group	Count	13	7	6	3	29
	Total %	14.44%	7.78%	6.67%	3.33%	32.22%
	Group %	**44.83%**	24.14%	20.69%	10.34%	100.00%
All Groups	Count	63	10	8	9	90
	Total %	**70.00%**	11.11%	8.89%	10.00%	100.00%

		Uncertainty/Thinking - Assessment				Uncertainty/Thinking - Interaction Choice			
		Verbal	**Gestural/ Visual**	**Both**	Totals	**Verbal**	**Gestural/ Visual**	**Both**	Totals
SIGs Group	Count	15	9	7	31	17	6	8	31
	Total %	**16.67%**	10.00%	7.78%	34.44%	**18.89%**	6.67%	8.89%	34.44%
	Group %	**48.39%**	29.03%	22.58%	100.00%	**54.84%**	19.35%	25.81%	100.00%
VCAs-SIGs Group	Count	14	5	11	30	24	1	5	30
	Total %	**15.56%**	5.56%	12.22%	33.33%	**26.67%**	1.11%	5.56%	33.33%
	Group %	**46.67%**	16.67%	36.67%	100.00%	**80.00%**	3.33%	16.67%	100.00%
VCAs Group	Count	20	4	5	29	17	4	8	29
	Total %	**22.22%**	4.44%	5.56%	32.22%	**18.89%**	4.44%	8.89%	32.22%
	Group %	**68.97%**	13.79%	17.24%	100.00%	**58.62%**	13.79%	27.59%	100.00%
All Groups	Count	49	18	23	90	58	11	21	90
	Total %	**54.44%**	20.00%	25.56%	100.00%	**64.44%**	12.22%	23.33%	100.00%

Uncertainty/Thinking - Checkmark actor

		G1			G2			
		X1	**X2**	**X3**	**X4**	**X5**	**X6**	Totals
SIGs Group	Count	0	28	0	1	2	1	31
	Total %	0.00%	31.11%	0.00%	1.11%	2.22%	1.11%	34.44%
	Group %	0.00%	90.32%	0.00%	3.23%	6.45%	3.23%	100.00%
VCAs-SIGs Group	Count	0	26	0	0	1	2	30
	Total %	0.00%	28.89%	0.00%	0.00%	1.11%	2.22%	33.33%
	Group %	0.00%	86.67%	0.00%	0.00%	3.33%	6.67%	100.00%
VCAs Group	Count	3	3	3	6	4	7	29
	Total %	3.33%	3.33%	3.33%	6.67%	4.44%	7.78%	32.22%
	Group %	10.34%	10.34%	10.34%	20.69%	13.79%	24.14%	100.00%
All Groups	Count	3	57	3	7	7	10	90
	Total %	3.33%	63.33%	3.33%	7.78%	7.78%	11.11%	100.00%

		Description of Uncertainty/Thinking - Assessment				
		Gestural/Visual	**Both**	**Verbal**	**Neutral No opinion**	Totals
SIGs Group	Count	24	0	2	5	31
	Total %	26.67%	0.00%	2.22%	5.56%	34.44%
	Group %	**77.42%**	0.00%	6.45%	16.13%	100.00%
VCAs-SIGs Group	Count	26	1	1	2	30
	Total %	28.89%	1.11%	1.11%	2.22%	33.33%
	Group %	**86.67%**	3.33%	3.33%	6.67%	100.00%
VCAs Group	Count	8	1	10	10	29
	Total %	8.89%	1.11%	11.11%	11.11%	32.22%
	Group %	27.59%	3.45%	**34.48%**	**34.48%**	100.00%
All Groups	Count	58	2	13	17	90
	Total %	**64.44%**	2.22%	14.44%	18.89%	100.00%

		Positive Feedback - Assessment				Positive Feedback - Interaction Choice			
		Verbal	**Gestural/ Visual**	**Both**	Totals	**Verbal**	**Gestural/ Visual**	**Both**	Totals
SIGs Group	Count	14	2	15	31	10	8	13	31
	Total %	15.56%	2.22%	**16.67%**	34.44%	11.11%	8.89%	**14.44%**	34.44%
	Group %	45.16%	6.45%	**48.39%**	100.00%	32.26%	25.81%	**41.94%**	100.00%
VCAs-SIGs Group	Count	13	1	16	30	13	7	10	30
	Total %	14.44%	1.11%	**17.78%**	33.33%	**14.44%**	7.78%	11.11%	33.33%
	Group %	43.33%	3.33%	**53.33%**	100.00%	**43.33%**	23.33%	33.33%	100.00%
VCAs Group	Count	24	0	5	29	17	2	10	29
	Total %	**26.67%**	0.00%	5.56%	32.22%	**18.89%**	2.22%	11.11%	32.22%
	Group %	**82.76%**	0.00%	17.24%	100.00%	**58.62%**	6.90%	34.48%	100.00%
All Groups	Count	51	3	36	90	40	17	33	90
	Total %	**56.67%**	3.33%	40.00%	100.00%	**44.44%**	18.89%	36.67%	100.00%

Positive Feedback - Checkmark actor

		G1			G2			
		X1	**X2**	**X3**	**X4**	**X5**	**X6**	Totals
SIGs Group	Count	17	14	5	7	3	5	31
	Total %	18.89%	15.56%	5.56%	7.78%	3.33%	5.56%	34.44%
	Group %	54.84%	45.16%	16.13%	22.58%	9.68%	16.13%	100.00%
VCAs-SIGs Group	Count	23	18	12	6	4	5	30
	Total %	25.56%	20.00%	13.33%	6.67%	4.44%	5.56%	33.33%
	Group %	76.67%	60.00%	40.00%	20.00%	13.33%	16.67%	100.00%
VCAs Group	Count	9	10	5	5	1	1	29
	Total %	10.00%	11.11%	5.56%	5.56%	1.11%	1.11%	32.22%
	Group %	31.03%	34.48%	17.24%	17.24%	3.45%	3.45%	100.00%
All Groups	Count	49	42	22	18	8	11	90
	Total %	54.44%	46.67%	24.44%	20.00%	8.89%	12.22%	100.00%

Description of Positive Feedback - Assessment

		Gestural/Visual	Both	Verbal	Neutral No opinion	Totals
SIGs Group	Count	8	3	5	15	31
	Total %	8.89%	3.33%	5.56%	16.67%	34.44%
	Group %	25.81%	9.68%	16.13%	**48.39%**	100.00%
VCAs-SIGs Group	Count	16	2	3	9	30
	Total %	17.78%	2.22%	3.33%	10.00%	33.33%
	Group %	**53.33%**	6.67%	10.00%	30.00%	100.00%
VCAs Group	Count	3	0	13	13	29
	Total %	3.33%	0.00%	14.44%	14.44%	32.22%
	Group %	10.34%	0.00%	**44.83%**	**44.83%**	100.00%
All Groups	Count	27	5	21	37	90
	Total %	30.00%	5.56%	23.33%	**41.11%**	100.00%

Visual Co-Activation - Assessment

		Active participation	Uncertainty/Thinking	Calling for attention	Avoid attention	
		Red border	**Dotted border**	**Numbers**	**Opacity change**	Totals
VCAs-SIGs Group	Count	25	22	27	24	30
	Total %	42.37%	37.29%	45.76%	40.68%	50.85%
	Group %	83.33%	73.33%	90.00%	80.00%	100.00%
VCAs Group	Count	23	18	25	22	29
	Total %	38.98%	30.51%	42.37%	37.29%	49.15%
	Group %	79.31%	62.07%	86.21%	75.86%	100.00%
All Groups	Count	48	40	52	46	59
	Total %	81.36%	67.80%	88.14%	77.97%	100.00%

	SIGs awareness - assessment			
				Totals
	yes	**some**	**no**	
SIGs Group	19	12	0	31
	21.11%	13.33%	0.00%	34.44%
	61.29%	38.71%	0.00%	100.00%
VCAs-SIGs Grou	18	9	3	30
	20.00%	10.00%	3.33%	33.33%
	60.00%	30.00%	10.00%	100.00%
VCAs Group	5	21	3	29
	5.56%	**23.33%**	3.33%	32.22%
	17.24%	**72.41%**	10.34%	100.00%
All Groups	42	42	6	90
	46.67%	**46.67%**	6.67%	100.00%

	SIGs amount awareness - assessment			
				Totals
	some	**many**	**lots**	
SIGs Group	15	14	2	31
	16.67%	15.56%	2.22%	34.44%
	48.39%	45.16%	6.45%	100.00%
VCAs-SIGs Grou	16	12	2	30
	17.78%	13.33%	2.22%	33.33%
	53.33%	40.00%	6.67%	100.00%
VCAs Group	10	18	1	29
	11.11%	**20.00%**	1.11%	32.22%
	34.48%	**62.07%**	3.45%	100.00%
All Groups	41	44	5	90
	45.56%	**48.89%**	5.56%	100.00%

	SIGs relevant in OLE		
			Totals
	yes	**no**	
SIGs Group	26	5	31
	28.89%	5.56%	34.44%
	83.87%	16.13%	100.00%
VCAs-SIGs Group	22	8	30
	24.44%	8.89%	33.33%
	73.33%	26.67%	100.00%
VCAs Group	25	4	29
	27.78%	4.44%	32.22%
	86.21%	13.79%	100.00%
All Groups	73	17	90
	81.11%	18.89%	100.00%

Recommend other mechanisms for OLE		
		Totals
yes	**no**	
19	12	31
21.11%	13.33%	34.44%
61.29%	38.71%	100.00%
20	10	30
22.22%	11.11%	33.33%
66.67%	33.33%	100.00%
19	10	29
21.11%	11.11%	32.22%
65.52%	34.48%	100.00%
58	32	90
64.44%	35.56%	100.00%

Relevance of Gestures in Online Learning Environments

		more visible - better than Verbal - better recognition	effective dynamic tool better inter and intra communication - regulator	more humane (gives more persona in de - similes face to face communication - real	more expressive - say more than words (replace words; emphasize words -	no reason or not applicable	Totals
SIGs Group	Count	6	11	2	4	8	31
	Total %	6.67%	12.22%	2.22%	4.44%	8.89%	34.44%
	Group %	19.35%	**35.48%**	6.45%	12.90%	25.81%	100.00%
VCAs-SIGs Group	Count	3	9	4	5	9	30
	Total %	3.33%	10.00%	4.44%	5.56%	10.00%	33.33%
	Group %	10.00%	**30.00%**	13.33%	16.67%	**30.00%**	100.00%
VCAs Group	Count	5	17	1	1	5	29
	Total %	5.56%	18.89%	1.11%	1.11%	5.56%	32.22%
	Group %	17.24%	**58.62%**	3.45%	3.45%	17.24%	100.00%
All Groups	Count	14	37	7	10	22	90
	Total %	15.56%	**41.11%**	7.78%	11.11%	24.44%	100.00%

Explain/Suggest Other Interactive Mechanisms

		add visual mechanisms (color - zoom in/out -signals)	add movement (more video streaming - gesture	add interaction (mechanisms various)	humanize the environment (more comfortable -	add timing control the response make it faster	add sound (improving - adjusting - stereo - signals -	no opinion / not applicable	Totals
SIGs Group	Count	8	1	4	1	1	3	13	31
	Total %	8.89%	1.11%	4.44%	1.11%	1.11%	3.33%	14.44%	34.44%
	Group %	**25.81%**	3.23%	12.90%	3.23%	3.23%	9.68%	**41.94%**	100.00%
VCAs-SIGs Group	Count	14	0	2	0	0	1	13	30
	Total %	15.56%	0.00%	2.22%	0.00%	0.00%	1.11%	14.44%	33.33%
	Group %	**46.67%**	0.00%	6.67%	0.00%	0.00%	3.33%	43.33%	100.00%
VCAs Group	Count	5	11	1	0	1	1	10	29
	Total %	5.56%	12.22%	1.11%	0.00%	1.11%	1.11%	11.11%	32.22%
	Group %	17.24%	**37.93%**	3.45%	0.00%	3.45%	3.45%	34.48%	100.00%
All Groups	Count	27	12	7	1	2	5	36	90
	Total %	**30.00%**	13.33%	7.78%	1.11%	2.22%	5.56%	**40.00%**	100.00%

```
SAS
Input Dataset

data temp;
  set Movie;
run;

options ls=80 ps=59 nodate; run;


/*********************************************************/
/*                                  Section 2
                                                          */
/*********************************************************/

/* question 1 */
data sec2 ;
  set temp;
  y=(kimatt + mikeatt + lisaatt)/3 - (saraatt + johnatt+willatt)/3;
  y1=(kimatt + mikeatt + lisaatt)/3;
  run;

 proc sort data=sec2;
   by Treatment;
run;

 proc means data=sec2 noprint;
   by Treatment;
   var y;
   output out=out2 mean=ave  stderr=se  n=no;
run;

title 'section2';
proc print data=out2; run;

 proc univariate data=sec2  ;
   var y;
 run;

 /* question 2 */
proc glm data=sec2;
   class Treatment;
   model y=Treatment;
   means Treatment / tukey duncan;
   contrast 'treat1 vs treat2' Treatment 1 -1 0;
   contrast 'treat2 vs treat3' Treatment 0 1 -1;
   contrast 'treat1 vs treat3' Treatment 1 0 -1;
   run;

/* question 3 */
   /* Using mcnemar test */
proc freq data=sec2;
  tables kimatt * (mikeatt lisaatt) / agree ;
  tables mikeatt * lisaatt / agree ;
run;


 /* question 4 */
  proc glm data=sec2;
   class Treatment;
   model y1=Treatment;
   means Treatment / tukey duncan;
   contrast 'treat1 vs treat2' Treatment 1 -1 0;
   contrast 'treat2 vs treat3' Treatment 0 1 -1;
```

```
   contrast 'treat1 vs treat3' Treatment 1 0 -1;
   run;


/*********************************************************/
/*                                   Section 3
       */
/*********************************************************/

/* question 1 */
data sec3 ;
  set temp;
  y=(kimavo + mikeavo + lisaavo)/3 - (saraavo + johnavo+willavo)/3;
  y1=(kimavo + mikeavo + lisaavo)/3;
  run;

 proc sort data=sec3;
   by Treatment;
run;

 proc means data=sec3 noprint;
   by Treatment;
   var y;
   output out=out3 mean=ave  stderr=se  n=no;
run;

title 'section3';
proc print data=out3; run;

 proc univariate data=sec3 ;
   var y;
 run;

 /* question 2 */
proc glm data=sec3;
   class Treatment;
   model y=Treatment;
   means Treatment / tukey duncan;
   contrast 'treat1 vs treat2' Treatment 1 -1 0;
   contrast 'treat2 vs treat3' Treatment 0 1 -1;
   contrast 'treat1 vs treat3' Treatment 1 0 -1;
   run;

/* question 3 */
   /* Using mcnemar test */
proc freq data=sec3;
  tables kimavo * (mikeavo lisaavo) / agree ;
  tables mikeavo * lisaavo / agree ;
run;

/* question 4 */
  proc glm data=sec3;
   class Treatment;
   model y1=Treatment;
   means Treatment / tukey duncan;
   contrast 'treat1 vs treat2' Treatment 1 -1 0;
   contrast 'treat2 vs treat3' Treatment 0 1 -1;
   contrast 'treat1 vs treat3' Treatment 1 0 -1;
   run;

/* question 5 */
proc freq data=sec3;
  tables Treatment * lisaavo / chisq;
run;
```

```
/*********************************************************/
/*                                   Section 4
       */
/*********************************************************/

/* question 1 */
data sec4 ;
  set temp;
  y=(kimunc + mikeunc + lisaunc)/3 - (saraunc + johnunc+willunc)/3;
  y1=(kimunc + mikeunc + lisaunc)/3;
  run;

 proc sort data=sec4;
   by Treatment;
run;

 proc means data=sec4 noprint;
   by Treatment;
   var y;
   output out=out4 mean=ave  stderr=se  n=no;
run;

title 'section4';
proc print data=out4; run;

 proc univariate data=sec4  ;
   var y;
 run;

 /* question 2 */
proc glm data=sec4;
   class Treatment;
   model y=Treatment;
   means Treatment /  tukey duncan;
   contrast 'treat1 vs treat2' Treatment 1 -1 0;
   contrast 'treat2 vs treat3' Treatment 0 1 -1;
   contrast 'treat1 vs treat3' Treatment 1 0 -1;
   run;

/* question 3 */
   /* Using mcnemar test */
proc freq data=sec4;
  tables kimunc * (mikeunc lisaunc) / agree ;
  tables mikeunc * lisaunc / agree ;
run;

 /* question 4 */
  proc glm data=sec4;
   class Treatment;
   model y1=Treatment;
   means Treatment / tukey duncan;
   contrast 'treat1 vs treat2' Treatment 1 -1 0;
   contrast 'treat2 vs treat3' Treatment 0 1 -1;
   contrast 'treat1 vs treat3' Treatment 1 0 -1;
   run;

/* question 5 */
proc freq data=sec4;
  tables Treatment * mikeunc / chisq;
run;
```

```
/*********************************************************/
/*                                   Section 5
       */
/*********************************************************/

/* question 1 */
data sec5 ;
  set temp;
  y=(kimpos + mikepos + lisapos)/3 - (sarapos + johnpos+willpos)/3;
  y1=(kimpos + mikepos + lisapos)/3;
  run;

 proc sort data=sec5;
   by Treatment;
run;

 proc means data=sec5 noprint;
   by Treatment;
   var y;
   output out=out5 mean=ave  stderr=se  n=no;
run;

title 'section5';
proc print data=out5; run;

 proc univariate data=sec5  ;
   var y;
 run;

 /* question 2 */
proc glm data=sec5;
   class Treatment;
   model y=Treatment;
   means Treatment / tukey duncan;
   contrast 'treat1 vs treat2' Treatment 1 -1 0;
   contrast 'treat2 vs treat3' Treatment 0 1 -1;
   contrast 'treat1 vs treat3' Treatment 1 0 -1;
   run;

/* question 3 */
   /* Using mcnemar test */
proc freq data=sec5;
  tables kimpos * (mikepos lisapos) / agree ;
  tables mikepos * lisapos / agree ;
run;

 /* question 4 */
  proc glm data=sec5;
   class Treatment;
   model y1=Treatment;
   means Treatment /  tukey duncan;
   contrast 'treat1 vs treat2' Treatment 1 -1 0;
   contrast 'treat2 vs treat3' Treatment 0 1 -1;
   contrast 'treat1 vs treat3' Treatment 1 0 -1;
   run;
```

section2

Obs	Treatment	_TYPE_	_FREQ_	ave	se	no
1	SIGs	0	31	0.79570	0.052823	31
2	VCAs	0	29	0.67816	0.069170	29
3	VCAs-	0	30	0.82222	0.049861	30

section2

The UNIVARIATE Procedure
Variable: y

Moments

N	90	Sum Weights	90
Mean	0.76666667	Sum Observations	69
Std Deviation	0.31780301	Variance	0.10099875
Skewness	-1.1169929	Kurtosis	0.06265995
Uncorrected SS	61.8888889	Corrected SS	8.98888889
Coeff Variation	41.4525662	Std Error Mean	0.03349938

Basic Statistical Measures

Location		Variability	
Mean	0.766667	Std Deviation	0.31780
Median	1.000000	Variance	0.10100
Mode	1.000000	Range	1.00000
		Interquartile Range	0.33333

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	22.886	Pr > |t|	<.0001
Sign	M	41	Pr >= |M|	<.0001
Signed Rank	S	1867.5	Pr >= |S|	<.0001

Quantiles (Definition 5)

Quantile	Estimate
100% Max	1.000000
99%	1.000000
95%	1.000000
90%	1.000000
75% Q3	1.000000
50% Median	1.000000
25% Q1	0.666667
10%	0.333333
5%	0.000000
1%	-0.000000
0% Min	-0.000000

```
                    Extreme Observations

          --------Lowest-------        ----Highest---

                 Value      Obs        Value      Obs

          -3.70255E-17       10            1       81
          -3.70255E-17        5            1       82
                            section2

                 The UNIVARIATE Procedure
                       Variable:  y

                    Extreme Observations

          --------Lowest-------        ----Highest---

                 Value      Obs        Value      Obs

           0.00000E+00       48            1       84
           0.00000E+00       44            1       85
           0.00000E+00       37            1       87
                            section2

                       The GLM Procedure

                 Class Level Information

           Class          Levels    Values

           Treatment           3    SIGs VCAs VCAs-


           Number of Observations Read          90
           Number of Observations Used          90
                            section2

                       The GLM Procedure

Dependent Variable: y

                                      Sum of
 Source                    DF        Squares    Mean Square   F Value   Pr > F

 Model                      2     0.34588638     0.17294319      1.74   0.1814

 Error                     87     8.64300251     0.09934486

 Corrected Total           89     8.98888889


              R-Square     Coeff Var      Root MSE        y Mean

              0.038479      41.11176      0.315190      0.766667
```

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	0.34588638	0.17294319	1.74	0.1814

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	0.34588638	0.17294319	1.74	0.1814

section2

The GLM Procedure

Duncan's Multiple Range Test for y

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	87
Error Mean Square	0.099345
Harmonic Mean of Cell Sizes	29.97777

NOTE: Cell sizes are not equal.

Number of Means	2	3
Critical Range	.1618	.1703

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Treatment
A	0.82222	30	VCAs-
A			
A	0.79570	31	SIGs
A			
A	0.67816	29	VCAs

section2

The GLM Procedure

Tukey's Studentized Range (HSD) Test for y

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	87
Error Mean Square	0.099345
Critical Value of Studentized Range	3.37219
Minimum Significant Difference	0.1941
Harmonic Mean of Cell Sizes	29.97777

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	Treatment
A	0.82222	30	VCAs-
A			
A	0.79570	31	SIGs
A			
A	0.67816	29	VCAs

section2

The GLM Procedure

Dependent Variable: y

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
treat1 vs treat2	1	0.20699749	0.20699749	2.08	0.1525
treat2 vs treat3	1	0.30602853	0.30602853	3.08	0.0828
treat1 vs treat3	1	0.01072527	0.01072527	0.11	0.7433

section2

The FREQ Procedure

Table of kimatt by mikeatt

kimatt mikeatt

Frequency Percent Row Pct Col Pct	0	1	Total
0	4 4.44 50.00 33.33	4 4.44 50.00 5.13	8 8.89
1	8 8.89 9.76 66.67	74 82.22 90.24 94.87	82 91.11
Total	12 13.33	78 86.67	90 100.00

Statistics for Table of kimatt by mikeatt

McNemar's Test

Statistic (S)	1.3333
DF	1

```
        Pr > S           0.2482


        Simple Kappa Coefficient
    --------------------------------
    Kappa                     0.3284
    ASE                       0.1478
    95% Lower Conf Limit      0.0386
    95% Upper Conf Limit      0.6181

            Sample Size = 90


                section2

            The FREQ Procedure

         Table of kimatt by lisaatt

   kimatt     lisaatt

   Frequency|
   Percent  |
   Row Pct  |
   Col Pct  |       0|       1|  Total
   ---------+--------+--------+
          0 |      5 |      3 |      8
            |   5.56 |   3.33 |   8.89
            |  62.50 |  37.50 |
            |  26.32 |   4.23 |
   ---------+--------+--------+
          1 |     14 |     68 |     82
            |  15.56 |  75.56 |  91.11
            |  17.07 |  82.93 |
            |  73.68 |  95.77 |
   ---------+--------+--------+
   Total          19       71       90
                21.11    78.89   100.00


Statistics for Table of kimatt by lisaatt

            McNemar's Test
        -----------------------
        Statistic (S)    7.1176
        DF                    1
        Pr > S           0.0076


        Simple Kappa Coefficient
    --------------------------------
    Kappa                     0.2803
    ASE                       0.1225
    95% Lower Conf Limit      0.0403
    95% Upper Conf Limit      0.5203

            Sample Size = 90
```

section2

The FREQ Procedure

Table of mikeatt by lisaatt

```
mikeatt     lisaatt

Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|  Total
---------+--------+--------+
       0 |      8 |      4 |     12
         |   8.89 |   4.44 |  13.33
         |  66.67 |  33.33 |
         |  42.11 |   5.63 |
---------+--------+--------+
       1 |     11 |     67 |     78
         |  12.22 |  74.44 |  86.67
         |  14.10 |  85.90 |
         |  57.89 |  94.37 |
---------+--------+--------+
Total          19       71       90
            21.11    78.89   100.00
```

Statistics for Table of mikeatt by lisaatt

McNemar's Test

Statistic (S)	3.2667
DF	1
Pr > S	0.0707

Simple Kappa Coefficient

Kappa	0.4216
ASE	0.1215
95% Lower Conf Limit	0.1835
95% Upper Conf Limit	0.6597

Sample Size = 90

section2

The GLM Procedure

Class Level Information

Class	Levels	Values
Treatment	3	SIGs VCAs VCAs-

```
                    Number of Observations Read          90
                    Number of Observations Used          90
                                   section2

                              The GLM Procedure

Dependent Variable: y1

                                          Sum of
 Source                     DF          Squares    Mean Square   F Value   Pr > F

 Model                       2       1.17769126     0.58884563     10.13   0.0001

 Error                      87       5.05564207     0.05811083

 Corrected Total            89       6.23333333


               R-Square     Coeff Var      Root MSE       y1 Mean

               0.188934      28.17606      0.241062      0.855556


 Source                     DF        Type I SS    Mean Square   F Value   Pr > F

 Treatment                   2       1.17769126     0.58884563     10.13   0.0001


 Source                     DF      Type III SS    Mean Square   F Value   Pr > F

 Treatment                   2       1.17769126     0.58884563     10.13   0.0001
                                   section2

                              The GLM Procedure

                      Duncan's Multiple Range Test for y1

   NOTE: This test controls the Type I comparisonwise error rate, not the
                          experimentwise error rate.


                      Alpha                            0.05
                      Error Degrees of Freedom           87
                      Error Mean Square            0.058111
                      Harmonic Mean of Cell Sizes 29.97777

                        NOTE: Cell sizes are not equal.


                    Number of Means          2          3
                    Critical Range       .1238      .1302


          Means with the same letter are not significantly different.


        Duncan Grouping          Mean       N    Treatment
```

```
                    A       0.93548     31    SIGs
                    A
                    A       0.93333     30    VCAs-

                    B       0.68966     29    VCAs
                                section2

                             The GLM Procedure

                Tukey's Studentized Range (HSD) Test for y1

NOTE: This test controls the Type I experimentwise error rate, but it generally
                has a higher Type II error rate than REGWQ.


                Alpha                                     0.05
                Error Degrees of Freedom                    87
                Error Mean Square                     0.058111
                Critical Value of Studentized Range    3.37219
                Minimum Significant Difference          0.1485
                Harmonic Mean of Cell Sizes           29.97777

                      NOTE: Cell sizes are not equal.


          Means with the same letter are not significantly different.


         Tukey Grouping          Mean      N    Treatment

                    A       0.93548     31    SIGs
                    A
                    A       0.93333     30    VCAs-

                    B       0.68966     29    VCAs
                                section2

                             The GLM Procedure

Dependent Variable: y1

 Contrast                   DF    Contrast SS    Mean Square   F Value   Pr > F

 treat1 vs treat2            1     0.90546904     0.90546904     15.58   0.0002
 treat2 vs treat3            1     0.87558932     0.87558932     15.07   0.0002
 treat1 vs treat3            1     0.00007051     0.00007051      0.00   0.9723
                                section3

       Obs    Treatment    _TYPE_    _FREQ_       ave         se       no

        1       SIGs          0        31       0.22581    0.080896    31
        2       VCAs          0        29      -0.14943    0.089983    29
        3       VCAs-         0        30       0.23333    0.060119    30
                                section3

                           The UNIVARIATE Procedure
```

Variable: y

Moments

N	90	Sum Weights	90
Mean	0.10740741	Sum Observations	9.66666667
Std Deviation	0.4575017	Variance	0.20930781
Skewness	-0.5781384	Kurtosis	-0.0579586
Uncorrected SS	19.6666667	Corrected SS	18.6283951
Coeff Variation	425.949863	Std Error Mean	0.04822491

Basic Statistical Measures

Location		Variability	
Mean	0.107407	Std Deviation	0.45750
Median	0.333333	Variance	0.20931
Mode	0.333333	Range	2.00000
		Interquartile Range	0.33333

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.227218	Pr > |t|	0.0285
Sign	M	11	Pr >= |M|	0.0169
Signed Rank	S	384	Pr >= |S|	0.0490

Quantiles (Definition 5)

Quantile	Estimate
100% Max	1.000000
99%	1.000000
95%	0.666667
90%	0.666667
75% Q3	0.333333
50% Median	0.333333
25% Q1	-0.000000
10%	-0.666667
5%	-0.666667
1%	-1.000000
0% Min	-1.000000

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
-1.000000	51	0.666667	82
-1.000000	40	0.666667	86

section3

The UNIVARIATE Procedure
Variable: y

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
-1.000000	24	1.000000	10
-0.666667	35	1.000000	25
-0.666667	85	1.000000	55

section3

The GLM Procedure

Class Level Information

Class	Levels	Values
Treatment	3	SIGs VCAs VCAs-

Number of Observations Read 90
Number of Observations Used 90

section3

The GLM Procedure

Dependent Variable: y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	2.82321647	1.41160823	7.77	0.0008
Error	87	15.80517859	0.18166872		
Corrected Total	89	18.62839506			

R-Square	Coeff Var	Root MSE	y Mean
0.151554	396.8312	0.426226	0.107407

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	2.82321647	1.41160823	7.77	0.0008

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	2.82321647	1.41160823	7.77	0.0008

section3

The GLM Procedure

Duncan's Multiple Range Test for y

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	87
Error Mean Square	0.181669
Harmonic Mean of Cell Sizes	29.97777

NOTE: Cell sizes are not equal.

Number of Means	2	3
Critical Range	.2188	.2303

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Treatment
A	0.2333	30	VCAs-
A			
A	0.2258	31	SIGs
B	-0.1494	29	VCAs

section3

The GLM Procedure

Tukey's Studentized Range (HSD) Test for y

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	87
Error Mean Square	0.181669
Critical Value of Studentized Range	3.37219
Minimum Significant Difference	0.2625
Harmonic Mean of Cell Sizes	29.97777

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	Treatment
A	0.2333	30	VCAs-
A			

```
A        0.2258     31    SIGs

B       -0.1494     29    VCAs
                 section3

                 The GLM Procedure

Dependent Variable: y

 Contrast                   DF    Contrast SS    Mean Square   F Value   Pr > F

 treat1 vs treat2            1     2.10963622     2.10963622     11.61   0.0010
 treat2 vs treat3            1     2.16031560     2.16031560     11.89   0.0009
 treat1 vs treat3            1     0.00086374     0.00086374      0.00   0.9452
                                 section3

                 The FREQ Procedure

              Table of kimavo by mikeavo

kimavo     mikeavo

Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|  Total
---------+--------+--------+
       0 |     67 |     15 |     82
         |  74.44 |  16.67 |  91.11
         |  81.71 |  18.29 |
         |  94.37 |  78.95 |
---------+--------+--------+
       1 |      4 |      4 |      8
         |   4.44 |   4.44 |   8.89
         |  50.00 |  50.00 |
         |   5.63 |  21.05 |
---------+--------+--------+
Total          71       19       90
            78.89    21.11   100.00


Statistics for Table of kimavo by mikeavo

           McNemar's Test
      -----------------------
      Statistic (S)    6.3684
      DF                    1
      Pr > S           0.0116


      Simple Kappa Coefficient
  --------------------------------
  Kappa                     0.1957
  ASE                       0.1187
  95% Lower Conf Limit     -0.0369
  95% Upper Conf Limit      0.4282
```

```
                Sample Size = 90


                    section3

               The FREQ Procedure

           Table of kimavo by lisaavo

      kimavo     lisaavo

      Frequency|
      Percent  |
      Row Pct  |
      Col Pct  |       0|       1|  Total
      ---------+--------+--------+
             0 |     37 |     45 |     82
               |  41.11 |  50.00 |  91.11
               |  45.12 |  54.88 |
               |  97.37 |  86.54 |
      ---------+--------+--------+
             1 |      1 |      7 |      8
               |   1.11 |   7.78 |   8.89
               |  12.50 |  87.50 |
               |   2.63 |  13.46 |
      ---------+--------+--------+
      Total          38       52       90
                  42.22    57.78   100.00


   Statistics for Table of kimavo by lisaavo

                  McNemar's Test
             ------------------------
             Statistic (S)    42.0870
             DF                     1
             Pr > S            <.0001


             Simple Kappa Coefficient
         --------------------------------
         Kappa                     0.0937
         ASE                       0.0483
         95% Lower Conf Limit     -0.0009
         95% Upper Conf Limit      0.1883

                Sample Size = 90


                    section3

               The FREQ Procedure

            Table of mikeavo by lisaavo

      mikeavo     lisaavo
```

```
Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|  Total
---------+--------+--------+
       0 |     31 |     40 |     71
         |  34.44 |  44.44 |  78.89
         |  43.66 |  56.34 |
         |  81.58 |  76.92 |
---------+--------+--------+
       1 |      7 |     12 |     19
         |   7.78 |  13.33 |  21.11
         |  36.84 |  63.16 |
         |  18.42 |  23.08 |
---------+--------+--------+
Total          38       52       90
            42.22    57.78   100.00


Statistics for Table of mikeavo by lisaavo

              McNemar's Test
         ------------------------
         Statistic (S)    23.1702
         DF                     1
         Pr > S            <.0001


         Simple Kappa Coefficient
     --------------------------------
     Kappa                     0.0417
     ASE                       0.0770
     95% Lower Conf Limit     -0.1092
     95% Upper Conf Limit      0.1926

             Sample Size = 90
                 section3

            The GLM Procedure

         Class Level Information

 Class          Levels    Values

 Treatment           3    SIGs VCAs VCAs-


 Number of Observations Read          90
 Number of Observations Used          90
                 section3

            The GLM Procedure

Dependent Variable: y1

                                   Sum of
 Source                    DF     Squares    Mean Square   F Value   Pr > F
```

Model	2	0.51246378	0.25623189	3.93	0.0232
Error	87	5.67148684	0.06518950		
Corrected Total	89	6.18395062			

R-Square	Coeff Var	Root MSE	y1 Mean
0.082870	87.26207	0.255322	0.292593

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	0.51246378	0.25623189	3.93	0.0232

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	0.51246378	0.25623189	3.93	0.0232

section3

The GLM Procedure

Duncan's Multiple Range Test for y1

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	87
Error Mean Square	0.06519
Harmonic Mean of Cell Sizes	29.97777

NOTE: Cell sizes are not equal.

Number of Means	2	3
Critical Range	.1311	.1379

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Treatment
A	0.35484	31	SIGs
A			
A	0.33333	30	VCAs-
B	0.18391	29	VCAs

section3

The GLM Procedure

Tukey's Studentized Range (HSD) Test for y1

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	87
Error Mean Square	0.06519
Critical Value of Studentized Range	3.37219
Minimum Significant Difference	0.1573
Harmonic Mean of Cell Sizes	29.97777

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

Tukey Grouping		Mean	N	Treatment
	A	0.35484	31	SIGs
	A			
B	A	0.33333	30	VCAs-
B				
B		0.18391	29	VCAs

section3

The GLM Procedure

Dependent Variable: y1

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
treat1 vs treat2	1	0.43777242	0.43777242	6.72	0.0112
treat2 vs treat3	1	0.32924216	0.32924216	5.05	0.0271
treat1 vs treat3	1	0.00705094	0.00705094	0.11	0.7430

section3

The FREQ Procedure

Table of Treatment by lisaavo

Treatment	lisaavo		
Frequency Percent Row Pct Col Pct	0	1	Total
SIGs	11 12.22 35.48 28.95	20 22.22 64.52 38.46	31 34.44
VCAs	19 21.11	10 11.11	29 32.22

```
                 |  65.52 |  34.48 |
                 |  50.00 |  19.23 |
         ---------+--------+--------+
         VCAs-     |      8 |     22 |     30
                 |   8.89 |  24.44 |  33.33
                 |  26.67 |  73.33 |
                 |  21.05 |  42.31 |
         ---------+--------+--------+
         Total          38       52       90
                     42.22    57.78   100.00
```

Statistics for Table of Treatment by lisaavo

Statistic	DF	Value	Prob
Chi-Square	2	10.0036	0.0067
Likelihood Ratio Chi-Square	2	10.0979	0.0064
Mantel-Haenszel Chi-Square	1	0.4417	0.5063
Phi Coefficient		0.3334	
Contingency Coefficient		0.3163	
Cramer's V		0.3334	

Sample Size = 90

section4

Obs	Treatment	_TYPE_	_FREQ_	ave	se	no
1	SIGs	0	31	0.25806	0.040041	31
2	VCAs	0	29	-0.09195	0.063850	29
3	VCAs-	0	30	0.25556	0.034587	30

section4

The UNIVARIATE Procedure

Variable: y

Moments

N	90	Sum Weights	90
Mean	0.14444444	Sum Observations	13
Std Deviation	0.30415352	Variance	0.09250936
Skewness	-1.5224944	Kurtosis	1.66115329
Uncorrected SS	10.1111111	Corrected SS	8.23333333
Coeff Variation	210.567821	Std Error Mean	0.0320606

Basic Statistical Measures

Location		Variability	
Mean	0.144444	Std Deviation	0.30415
Median	0.333333	Variance	0.09251
Mode	0.333333	Range	1.33333
		Interquartile Range	0.33333

Tests for Location: Mu0=0

```
Test           -Statistic-    -----p Value------

Student's t    t  4.505357    Pr > |t|    <.0001
Sign           M      20.5    Pr >= |M|   <.0001
Signed Rank    S       760    Pr >= |S|   <.0001


            Quantiles (Definition 5)

            Quantile       Estimate

            100% Max       0.333333
            99%            0.333333
            95%            0.333333
            90%            0.333333
            75% Q3         0.333333
            50% Median     0.333333
            25% Q1         0.000000
            10%           -0.333333
            5%            -0.333333
            1%            -1.000000
            0% Min        -1.000000


              Extreme Observations

  ------Lowest------        ------Highest-----

      Value      Obs            Value      Obs

  -1.000000       35         0.333333       84
  -0.666667       57         0.333333       85
                    section4

            The UNIVARIATE Procedure
                  Variable:  y

              Extreme Observations

  ------Lowest------        ------Highest-----

      Value      Obs            Value      Obs

  -0.666667       24         0.333333       86
  -0.333333       32         0.333333       89
  -0.333333       74         0.333333       90
                    section4

               The GLM Procedure

            Class Level Information

    Class          Levels    Values

    Treatment           3    SIGs VCAs VCAs-
```

```
                    Number of Observations Read          90
                    Number of Observations Used          90
                                   section4

                              The GLM Procedure

Dependent Variable: y

                                        Sum of
 Source                     DF        Squares    Mean Square   F Value   Pr > F

 Model                       2     2.39120834     1.19560417     17.80   <.0001

 Error                      87     5.84212499     0.06715086

 Corrected Total            89     8.23333333


               R-Square     Coeff Var      Root MSE        y Mean

               0.290430      179.4010      0.259135      0.144444


 Source                     DF      Type I SS    Mean Square   F Value   Pr > F

 Treatment                   2     2.39120834     1.19560417     17.80   <.0001


 Source                     DF    Type III SS    Mean Square   F Value   Pr > F

 Treatment                   2     2.39120834     1.19560417     17.80   <.0001
                                   section4

                              The GLM Procedure

                       Duncan's Multiple Range Test for y

   NOTE: This test controls the Type I comparisonwise error rate, not the
                          experimentwise error rate.


                     Alpha                           0.05
                     Error Degrees of Freedom          87
                     Error Mean Square           0.067151
                     Harmonic Mean of Cell Sizes 29.97777

                       NOTE: Cell sizes are not equal.


                    Number of Means          2          3
                    Critical Range       .1330      .1400


          Means with the same letter are not significantly different.
```

```
        Duncan Grouping          Mean      N    Treatment

                     A       0.25806     31    SIGs
                     A
                     A       0.25556     30    VCAs-

                     B      -0.09195     29    VCAs
                                   section4

                              The GLM Procedure

                    Tukey's Studentized Range (HSD) Test for y

NOTE: This test controls the Type I experimentwise error rate, but it generally
                  has a higher Type II error rate than REGWQ.


                  Alpha                                     0.05
                  Error Degrees of Freedom                    87
                  Error Mean Square                     0.067151
                  Critical Value of Studentized Range    3.37219
                  Minimum Significant Difference          0.1596
                  Harmonic Mean of Cell Sizes           29.97777

                        NOTE: Cell sizes are not equal.


          Means with the same letter are not significantly different.


         Tukey Grouping          Mean      N    Treatment

                     A       0.25806     31    SIGs
                     A
                     A       0.25556     30    VCAs-

                     B      -0.09195     29    VCAs
                                   section4

                              The GLM Procedure

Dependent Variable: y

 Contrast                   DF    Contrast SS    Mean Square   F Value   Pr > F

 treat1 vs treat2            1     1.83565278     1.83565278     27.34   <.0001
 treat2 vs treat3            1     1.78074117     1.78074117     26.52   <.0001
 treat1 vs treat3            1     0.00009597     0.00009597      0.00   0.9699
                                   section4

                              The FREQ Procedure

                            Table of kimunc by mikeunc

                     kimunc     mikeunc

                     Frequency|
```

```
Percent  |
Row Pct  |
Col Pct  |       0|       1|  Total
---------+--------+--------+
       0 |     30 |     57 |     87
         |  33.33 |  63.33 |  96.67
         |  34.48 |  65.52 |
         |  90.91 | 100.00 |
---------+--------+--------+
       1 |      3 |      0 |      3
         |   3.33 |   0.00 |   3.33
         | 100.00 |   0.00 |
         |   9.09 |   0.00 |
---------+--------+--------+
Total          33       57       90
            36.67    63.33   100.00
```

Statistics for Table of kimunc by mikeunc

```
            McNemar's Test
        ------------------------
        Statistic (S)    48.6000
        DF                     1
        Pr > S            <.0001


        Simple Kappa Coefficient
      --------------------------------
      Kappa                    -0.0676
      ASE                       0.0389
      95% Lower Conf Limit     -0.1438
      95% Upper Conf Limit      0.0085

            Sample Size = 90


                section4

            The FREQ Procedure

         Table of kimunc by lisaunc

kimunc     lisaunc

Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|  Total
---------+--------+--------+
       0 |     84 |      3 |     87
         |  93.33 |   3.33 |  96.67
         |  96.55 |   3.45 |
         |  96.55 | 100.00 |
---------+--------+--------+
       1 |      3 |      0 |      3
         |   3.33 |   0.00 |   3.33
```

```
          | 100.00 |   0.00 |
          |   3.45 |   0.00 |
---------+--------+--------+
Total          87        3       90
            96.67     3.33   100.00


Statistics for Table of kimunc by lisaunc

            McNemar's Test
        -----------------------
        Statistic (S)    0.0000
        DF                    1
        Pr > S           1.0000


        Simple Kappa Coefficient
     --------------------------------
     Kappa                    -0.0345
     ASE                       0.0141
     95% Lower Conf Limit     -0.0621
     95% Upper Conf Limit     -0.0069

            Sample Size = 90


                section4

            The FREQ Procedure

       Table of mikeunc by lisaunc

   mikeunc     lisaunc

   Frequency|
   Percent  |
   Row Pct  |
   Col Pct  |       0|       1|  Total
   ---------+--------+--------+
          0 |     30 |      3 |     33
            |  33.33 |   3.33 |  36.67
            |  90.91 |   9.09 |
            |  34.48 | 100.00 |
   ---------+--------+--------+
          1 |     57 |      0 |     57
            |  63.33 |   0.00 |  63.33
            | 100.00 |   0.00 |
            |  65.52 |   0.00 |
   ---------+--------+--------+
   Total          87        3       90
               96.67     3.33   100.00


Statistics for Table of mikeunc by lisaunc

             McNemar's Test
        -----------------------
```

```
                    Statistic (S)    48.6000
                    DF                     1
                    Pr > S            <.0001


                    Simple Kappa Coefficient
                --------------------------------
                Kappa                    -0.0676
                ASE                       0.0389
                95% Lower Conf Limit     -0.1438
                95% Upper Conf Limit      0.0085

                        Sample Size = 90
                            section4

                       The GLM Procedure

                    Class Level Information

            Class          Levels    Values

            Treatment           3    SIGs VCAs VCAs-


            Number of Observations Read          90
            Number of Observations Used          90
                            section4

                       The GLM Procedure

Dependent Variable: y1

                                        Sum of
 Source                     DF        Squares    Mean Square   F Value   Pr > F

 Model                       2     0.72408437     0.36204219     22.89   <.0001

 Error                      87     1.37591563     0.01581512

 Corrected Total            89     2.10000000


              R-Square     Coeff Var      Root MSE       y1 Mean

              0.344802      53.89637      0.125758      0.233333


 Source                     DF      Type I SS    Mean Square   F Value   Pr > F

 Treatment                   2     0.72408437     0.36204219     22.89   <.0001


 Source                     DF    Type III SS    Mean Square   F Value   Pr > F

 Treatment                   2     0.72408437     0.36204219     22.89   <.0001
                                     section4
```

```
                    The GLM Procedure

            Duncan's Multiple Range Test for y1

NOTE: This test controls the Type I comparisonwise error rate, not the
                 experimentwise error rate.


            Alpha                           0.05
            Error Degrees of Freedom          87
            Error Mean Square           0.015815
            Harmonic Mean of Cell Sizes 29.97777

              NOTE: Cell sizes are not equal.


          Number of Means           2           3
          Critical Range       .06456      .06794


     Means with the same letter are not significantly different.


   Duncan Grouping          Mean      N    Treatment

              A       0.30108     31    SIGs
              A
              A       0.28889     30    VCAs-

              B       0.10345     29    VCAs
                            section4

                    The GLM Procedure

           Tukey's Studentized Range (HSD) Test for y1

NOTE: This test controls the Type I experimentwise error rate, but it generally
           has a higher Type II error rate than REGWQ.


           Alpha                                  0.05
           Error Degrees of Freedom                 87
           Error Mean Square                  0.015815
           Critical Value of Studentized Range  3.37219
           Minimum Significant Difference        0.0775
           Harmonic Mean of Cell Sizes         29.97777

              NOTE: Cell sizes are not equal.


     Means with the same letter are not significantly different.


  Tukey Grouping          Mean      N    Treatment

              A       0.30108     31    SIGs
              A
```

```
A       0.28889     30    VCAs-

B       0.10345     29    VCAs
```

section4

The GLM Procedure

Dependent Variable: y1

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
treat1 vs treat2	1	0.58519548	0.58519548	37.00	<.0001
treat2 vs treat3	1	0.50708055	0.50708055	32.06	<.0001
treat1 vs treat3	1	0.00226414	0.00226414	0.14	0.7061

section4

The FREQ Procedure

Table of Treatment by mikeunc

Treatment	mikeunc		
Frequency / Percent / Row Pct / Col Pct	0	1	Total
SIGs	3 3.33 9.68 9.09	28 31.11 90.32 49.12	31 34.44
VCAs	26 28.89 89.66 78.79	3 3.33 10.34 5.26	29 32.22
VCAs-	4 4.44 13.33 12.12	26 28.89 86.67 45.61	30 33.33
Total	33 36.67	57 63.33	90 100.00

Statistics for Table of Treatment by mikeunc

Statistic	DF	Value	Prob
Chi-Square	2	51.8211	<.0001
Likelihood Ratio Chi-Square	2	55.7254	<.0001
Mantel-Haenszel Chi-Square	1	0.1304	0.7180
Phi Coefficient		0.7588	
Contingency Coefficient		0.6045	
Cramer's V		0.7588	

Sample Size = 90
section5

Obs	Treatment	_TYPE_	_FREQ_	ave	se	no
1	SIGs	0	31	0.22581	0.074755	31
2	VCAs	0	29	0.19540	0.053650	29
3	VCAs-	0	30	0.42222	0.081389	30

section5

The UNIVARIATE Procedure
Variable: y

Moments

N	90	Sum Weights	90
Mean	0.28148148	Sum Observations	25.3333333
Std Deviation	0.39947253	Variance	0.1595783
Skewness	0.14680926	Kurtosis	-0.6967934
Uncorrected SS	21.3333333	Corrected SS	14.2024691
Coeff Variation	141.917874	Std Error Mean	0.0421081

Basic Statistical Measures

Location		Variability	
Mean	0.281481	Std Deviation	0.39947
Median	0.333333	Variance	0.15958
Mode	0.000000	Range	1.66667
		Interquartile Range	0.66667

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	6.684734	Pr > |t|	<.0001
Sign	M	19.5	Pr >= |M|	<.0001
Signed Rank	S	694	Pr >= |S|	<.0001

Quantiles (Definition 5)

Quantile	Estimate
100% Max	1.000000
99%	1.000000
95%	1.000000
90%	0.833333
75% Q3	0.666667
50% Median	0.333333
25% Q1	0.000000
10%	-0.333333
5%	-0.333333
1%	-0.666667
0% Min	-0.666667

```
                    Extreme Observations

          ------Lowest------        ----Highest---

              Value      Obs        Value      Obs

          -0.666667        6            1       72
          -0.333333       65            1       76
                         section5

                 The UNIVARIATE Procedure
                       Variable:  y

                    Extreme Observations

          ------Lowest------        ----Highest---

              Value      Obs        Value      Obs

          -0.333333       64            1       77
          -0.333333       19            1       78
          -0.333333       15            1       84
                         section5

                     The GLM Procedure

                 Class Level Information

          Class          Levels    Values

          Treatment           3    SIGs VCAs VCAs-


          Number of Observations Read          90
          Number of Observations Used          90
                         section5

                     The GLM Procedure

Dependent Variable: y

                                        Sum of
 Source                     DF        Squares    Mean Square   F Value   Pr > F

 Model                       2     0.90520881     0.45260440      2.96   0.0570

 Error                      87    13.29726033     0.15284207

 Corrected Total            89    14.20246914


               R-Square     Coeff Var      Root MSE        y Mean

               0.063736      138.8902      0.390950      0.281481
```

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	2	0.90520881	0.45260440	2.96	0.0570

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	2	0.90520881	0.45260440	2.96	0.0570

section5

The GLM Procedure

Duncan's Multiple Range Test for y

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	87
Error Mean Square	0.152842
Harmonic Mean of Cell Sizes	29.97777

NOTE: Cell sizes are not equal.

Number of Means	2	3
Critical Range	.2007	.2112

Means with the same letter are not significantly different.

Duncan Grouping		Mean	N	Treatment
	A	0.4222	30	VCAs-
	A			
B	A	0.2258	31	SIGs
B				
B		0.1954	29	VCAs

section5

The GLM Procedure

Tukey's Studentized Range (HSD) Test for y

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	87
Error Mean Square	0.152842
Critical Value of Studentized Range	3.37219
Minimum Significant Difference	0.2408
Harmonic Mean of Cell Sizes	29.97777

NOTE: Cell sizes are not equal.

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	Treatment
A	0.4222	30	VCAs-
A			
A	0.2258	31	SIGs
A			
A	0.1954	29	VCAs

section5

The GLM Procedure

Dependent Variable: y

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
treat1 vs treat2	1	0.01385078	0.01385078	0.09	0.7641
treat2 vs treat3	1	0.75862935	0.75862935	4.96	0.0285
treat1 vs treat3	1	0.58817400	0.58817400	3.85	0.0530

section5

The FREQ Procedure

Table of kimpos by mikepos

kimpos mikepos

Frequency Percent Row Pct Col Pct	0	1	Total
0	33 36.67 80.49 68.75	8 8.89 19.51 19.05	41 45.56
1	15 16.67 30.61 31.25	34 37.78 69.39 80.95	49 54.44
Total	48 53.33	42 46.67	90 100.00

Statistics for Table of kimpos by mikepos

McNemar's Test

Statistic (S)	2.1304

```
DF                    1
Pr > S           0.1444


Simple Kappa Coefficient
--------------------------------
Kappa                     0.4919
ASE                       0.0904
95% Lower Conf Limit      0.3147
95% Upper Conf Limit      0.6691

        Sample Size = 90


            section5

        The FREQ Procedure

     Table of kimpos by lisapos

kimpos     lisapos

Frequency|
Percent  |
Row Pct  |
Col Pct  |       0|       1|  Total
---------+--------+--------+
       0 |     37 |      4 |     41
         |  41.11 |   4.44 |  45.56
         |  90.24 |   9.76 |
         |  54.41 |  18.18 |
---------+--------+--------+
       1 |     31 |     18 |     49
         |  34.44 |  20.00 |  54.44
         |  63.27 |  36.73 |
         |  45.59 |  81.82 |
---------+--------+--------+
Total          68       22       90
            75.56    24.44   100.00


Statistics for Table of kimpos by lisapos

            McNemar's Test
        ------------------------
        Statistic (S)    20.8286
        DF                     1
        Pr > S            <.0001


Simple Kappa Coefficient
--------------------------------
Kappa                     0.2560
ASE                       0.0815
95% Lower Conf Limit      0.0963
95% Upper Conf Limit      0.4158
```

```
                Sample Size = 90


                    section5

               The FREQ Procedure

           Table of mikepos by lisapos

      mikepos     lisapos

      Frequency|
      Percent  |
      Row Pct  |
      Col Pct  |       0|       1|  Total
      ---------+--------+--------+
             0 |     45 |      3 |     48
               |  50.00 |   3.33 |  53.33
               |  93.75 |   6.25 |
               |  66.18 |  13.64 |
      ---------+--------+--------+
             1 |     23 |     19 |     42
               |  25.56 |  21.11 |  46.67
               |  54.76 |  45.24 |
               |  33.82 |  86.36 |
      ---------+--------+--------+
      Total          68       22       90
                   75.56    24.44   100.00


    Statistics for Table of mikepos by lisapos

                  McNemar's Test
             ------------------------
             Statistic (S)    15.3846
             DF                     1
             Pr > S            <.0001


             Simple Kappa Coefficient
         --------------------------------
         Kappa                     0.4018
         ASE                       0.0874
         95% Lower Conf Limit      0.2305
         95% Upper Conf Limit      0.5732

                Sample Size = 90
                    section5

               The GLM Procedure

             Class Level Information

     Class          Levels    Values

     Treatment           3    SIGs VCAs VCAs-
```

```
                    Number of Observations Read          90
                    Number of Observations Used          90
                                   section5

                              The GLM Procedure

Dependent Variable: y1

                                          Sum of
 Source                     DF          Squares    Mean Square   F Value   Pr > F

 Model                       2       1.49156401     0.74578201      5.86   0.0041

 Error                      87      11.07757179     0.12732841

 Corrected Total            89      12.56913580


               R-Square     Coeff Var      Root MSE       y1 Mean

               0.118669      85.26052      0.356831      0.418519


 Source                     DF        Type I SS    Mean Square   F Value   Pr > F

 Treatment                   2       1.49156401     0.74578201      5.86   0.0041


 Source                     DF      Type III SS    Mean Square   F Value   Pr > F

 Treatment                   2       1.49156401     0.74578201      5.86   0.0041
                                   section5

                              The GLM Procedure

                      Duncan's Multiple Range Test for y1

   NOTE: This test controls the Type I comparisonwise error rate, not the
                          experimentwise error rate.


                      Alpha                           0.05
                      Error Degrees of Freedom          87
                      Error Mean Square           0.127328
                      Harmonic Mean of Cell Sizes 29.97777

                        NOTE: Cell sizes are not equal.


                    Number of Means          2          3
                    Critical Range       .1832      .1928


          Means with the same letter are not significantly different.
```

```
        Duncan Grouping          Mean      N    Treatment

                     A       0.58889     30    VCAs-

                     B       0.38710     31    SIGs
                     B
                     B       0.27586     29    VCAs
                                   section5

                              The GLM Procedure

                   Tukey's Studentized Range (HSD) Test for y1

NOTE: This test controls the Type I experimentwise error rate, but it generally
                   has a higher Type II error rate than REGWQ.


                   Alpha                                      0.05
                   Error Degrees of Freedom                     87
                   Error Mean Square                      0.127328
                   Critical Value of Studentized Range     3.37219
                   Minimum Significant Difference           0.2198
                   Harmonic Mean of Cell Sizes            29.97777

                         NOTE: Cell sizes are not equal.


           Means with the same letter are not significantly different.


            Tukey Grouping          Mean      N    Treatment

                         A       0.58889     30    VCAss-
                         A
                   B     A       0.38710     31    SIGs
                   B
                   B             0.27586     29    VCAss
                                   section5

                              The GLM Procedure

Dependent Variable: y1

 Contrast                   DF    Contrast SS    Mean Square   F Value   Pr > F

 treat1 vs treat2            1     0.18539118     0.18539118      1.46   0.2308
 treat2 vs treat3            1     1.44487521     1.44487521     11.35   0.0011
 treat1 vs treat3            1     0.62081399     0.62081399      4.88   0.0299
```